# Los Alamos National Laboratory

## Critical Skills Development and Science Education Program

*Progress Report*

*October 1, 2000–September 30, 2001*

# Los Alamos National Laboratory

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# Executive Summary

The 2000–2001 Progress Report highlights one year of progress in Critical Skills Development and Science Education at Los Alamos National Laboratory (LANL). With a focus on the Laboratory mission—to serve the nation by applying the best science and technology to make the world a better and safer place—we made significant and unique contributions toward building the future technical workforce.

During the year, over 1,800 students participated in research and learning activities in the fields of science, engineering, technology and mathematics. The Office of University Partnerships of the National Nuclear Security Agency (NNSA), Department of Energy (DOE), primarily fund the student experiences. Additional funding is provided from other DOE offices, the National Science Foundation (NSF), the New Mexico Department of Education, the Commission on Higher Education, National Aeronautics and Space Administration (NASA), and others.

The Critical Skills Development and Science Education Program applies the scientific and technical resources of the Laboratory to critical needs in workforce development and education. Our goals are to

- Identify, develop, and inspire future scientific leaders
- Ensure a highly trained, diverse workforce
- Facilitate systemic change in mathematics and science education
- Serve as a national model to improve the quality of science, mathematics, engineering, and technology education

Section 1 of this report covers Critical Skills Development projects supported jointly by DOE and LANL management. New projects for 2000–2001 cover materials technology and high explosives engineering. Ongoing projects include physics and engineering summer schools, *f*-element and radiochemistry courses, mathematics and robotics competitions, the supercomputing challenge and career development in computer science. Each of these projects are driven by critical skill needs, designed with well-defined objectives, and structured so that students have an extended educational experience at the Laboratory.

Section 2 provides a description of the high school co-op, undergraduate, and graduate student programs.

Section 3 summarizes targeted student internship programs. The Morehouse College and College Co-op programs were new for 2000-2001. The Hertz Scholars Program was greatly expanded this year. The feature program in northern New Mexico was the Math and Science Academy. This was the final year for the Teacher Opportunities to Promote Science (TOPS) program. Continuing internship programs included the Fuel Cell Documentary, National Consortium for Graduate Degrees for Minorities in Engineering and Science, Massachusetts Institute of Technology (MIT) Engineering Internship Program, National Physical Science Consortium, Oak Ridge Institute of Science and Education, and South Carolina Universities Research and Education Foundation.

The Critical Skills Development and Science Education Program at Los Alamos is highly valuable to the Laboratory and to the Department of Energy. We are very proud of our accomplishments recorded here and look forward to future work with enthusiasm.

# Section 1

# Critical Skills Development and Science Education Programs

Supported by the
Department of Energy
Office of Defense Programs

# Adventures in Supercomputing Challenge

## Program Description

The New Mexico High School Supercomputing Challenge is a two-fold educational program that offers a truly unique experience to students and teachers in our state. Primarily, it is an academic-year-long program in which teams of one to five high school students conduct computational science projects using high-performance supercomputers. Secondly, during the summer months, it is a computational science- and technology-training program for high school teachers.

The program is both an educational experience and a competition that strives to (1) increase students' knowledge of and interest in science-related disciplines, (2) expose students and teachers to computational experiences, (3) promote careers in science and engineering, (4) provide access to high-performance computers, and (5) institute electronic networking among schools.

## Student Program

Every registered participant receives an account on a high-performance computer at Los Alamos National Laboratory. This computer is readily accessible via the Internet. If Internet access is not available through school or home, co-sponsor New Mexico Technet provides access to the Internet by providing telephone dial-up accounts.

Each team defines and works on a single computational science project of its own design. Computational science is a discipline in which a scientific problem, be it one of biology, physics, geology, medicine, engineering, or any other field, is modeled by one or more mathematical equations. These equations are typically so computationally intensive that a computer, where the work can be accomplished in relatively little time, must solve them. Similarly, the output can be so complex that a computer must also interpret it.

Primary instruction and support is given to the participants during the year as follows:

- Three-day Kickoff Conference in October—Instruction in project development, teamwork, programming, mathematical modeling, Unix, and other topics.
- School visits to requesting schools in November—Special assistance to schools requesting assistance with computers, networking, programming, or other issues.
- Regional workshops in January—Small workshops held at sponsoring universities and colleges statewide. Students present the progress on their projects and attend classes in programming, computer graphics, and technical writing.
- Project evaluation sessions in February—Semi-formal presentations, also held at sponsoring universities and colleges statewide, to a group of scientists who critique and provide feedback about their projects.
- Year-round online consulting—Technical support from Challenge consultants at Los Alamos National Laboratory by means of e-mail and telephone.

The sponsoring teachers provide year-round instruction and support as well. Many have been trained in the art of computational science during the Summer Teacher Training Sessions made available by the Challenge. Additionally, every effort is made to find mentors to help guide the teams through their projects. Very often, these people formally specialize in the area of science or engineering that the student projects reflect. Various deadlines are posted throughout the year.

In general, the project abstract is due in late October, an interim report by mid-January, and the final report by early April.

The academic-year program culminates with an awards ceremony at the Laboratory (Fig. 1). Project finalists arrive a day in advance to present their projects to a panel of scientists from the national laboratories, industry, and academia. On awards day, prizes and awards are bestowed upon those teams whose projects demonstrate a high level of quality in one manner or another. Additionally, scholarships from universities throughout New Mexico are awarded on an individual basis to qualified Challenge participants. To finish the day off, students partake in special tours, talks, and demonstrations around the Laboratory, as well as a student poster contest.

## Teacher Program

During the summer, a two-week Summer Teacher Training Session is held at an institution of higher education in New Mexico. Participating teachers are instructed in such topics as computational science, mathematical modeling, programming, Web page design, networking, and other topics. Additionally, individuals receive three units of graduate credit for their work.

The Challenge pays for instructors, facilities, books, graduate credits, housing, and stipends for food and miscellaneous expenses. Instructors come directly from Los Alamos National Laboratory and help to further enhance the Laboratory's relations with the communities of New Mexico.

Teachers who have attended the Summer Teacher Training Session become better able to support their students' endeavors in the Challenge, as well as develop into healthier computational scientists themselves. Although the days of instruction are intense, teachers always learn a lot and say that they would recommend the sessions to others.

## Recruiting Strategy

The Challenge is open to all interested students in grades 9 through 12 on a nonselective basis. The program has no grade point requirement, class enrollment, or computer experience prerequisites. Participants come from public, private, parochial, and home-based schools in all areas of New Mexico. The important requirement for

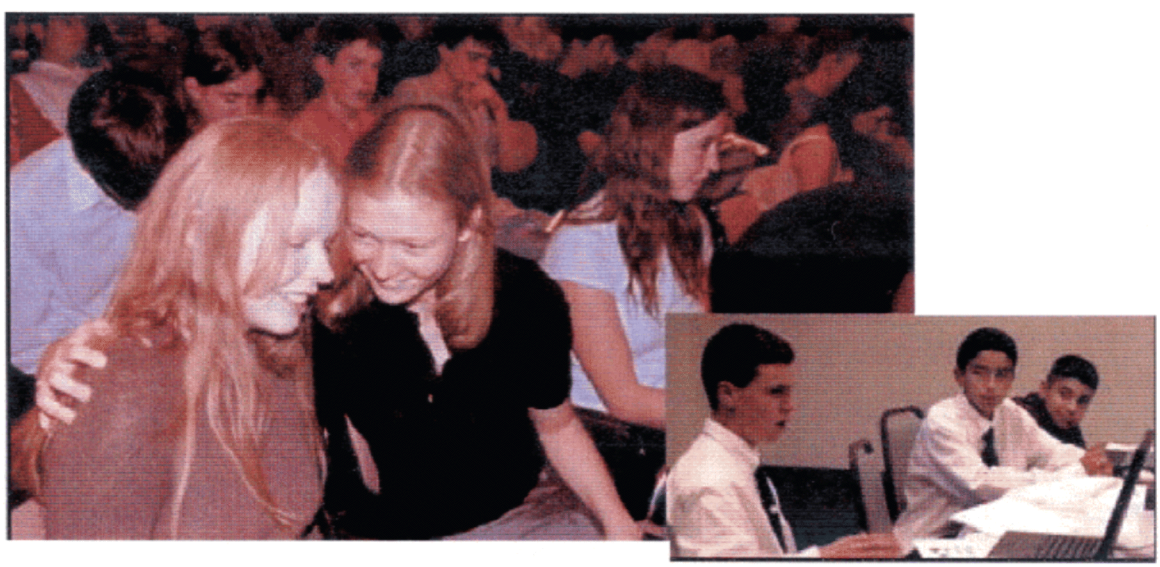


*Figure 1. 2001 Awards Day. First Place Team from Sandia Preparatory School and Judges Special Recognition Award winners from Picacho Middle School (inset).*

participating is a real desire to learn about science and computing. Promotion of the Challenge is accomplished through school visits by Challenge coordinators, attendance at conferences and workshops by coordinators and other Laboratory technical staff members for the purpose of encouraging participation, and promotion among their peers by past Challenge participants. In addition, a portion of the Laboratory's booth at Supercomputing '00 was a Challenge display.

Participants are "recruited" to the Laboratory in many informal ways. For example:

- Laboratory employees, who serve as instructors, mentors, and judges, often hire Challenge participants with whom they interact.
- During the three-day Kickoff Conference in October, the Laboratory's Student Programs Office representatives solicit students for future employment.
- Challenge participants are made aware of opportunities and research activities through various talks and demonstrations given by Laboratory personnel during the Awards Day activities in April.
- At various Challenge events around the state, David Kratzer and Eric Ovaska discuss opportunities at the Laboratory with students. From this exposure, we see many top-level students pursuing Laboratory employment.

## Performance Objective and Milestones

The primary objective of the Challenge is to foster creativity in devising computational solutions to scientific problems and to make a positive difference in students' lives, motivating them to prepare for the work force of the future. This objective will meet the goals of (1) increasing the quality and diversity of the hiring pool for NNSA laboratories (2) building a pipeline of quality Challenge students targeted as potential critical skills employees, and (3) connecting students and technical staff at the Laboratory.

## FY01 Milestones

- Three new scholarships were added this year, for a total of twelve. Compaq gave the Challenge two (2) $2,500 scholarships and one (1) for $3,000. For a complete listing see http://www.challenge.nm.org/scholarships.shtml. During the awards ceremony this year, over $28,000 was handed out in scholarships.
- Three new classes were introduced this year. Perl programming, as well as the StarLogo and Matlab simulation tools have been added to our curriculum. The Challenge continues to provide a boost to schools, giving them access to the latest in computing hardware architectures and programming techniques.
- Middle school students were allowed to participate for the first time. Jean McCray, a technologist from Picacho Middle School in Las Cruces, attended our Summer Teacher Institute at Western New Mexico University. She enrolled 12 of Picacho's best students into the Challenge. One of her teams won the Judges Special Recognition Award.

Since 1990, new organizations in New Mexico have continually joined with the Laboratory and New Mexico Technet to sponsor the Challenge. New sponsors include NASA and Compaq.

Ethnic representation for students can be seen in Chart 1. We believe that the Challenge has been successful in reaching out to a diverse population.

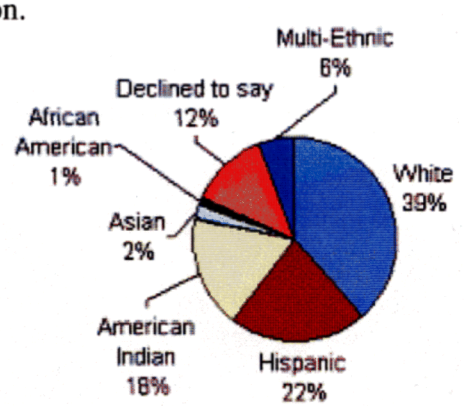



*Chart 1. Ethnic representation—Adventures in Supercomputing.*

Over 75% were new students and 27% were new teachers of the total student and teacher populations respectively.

The Challenge has directly addressed Los Alamos National Laboratory's Stockpile Stewardship Critical Skills Area #3: HPC- High Performance Computing and Simulation. The official definition of High Performance Computing and Simulation includes: Computer operations—Challenge students learn how to remotely access and operate high-performance computers; computer and computational science and math—students learn computer programming at Challenge events and use computational science and math within their computer programs to carry out their projects; code development and code maintenance—the students continually update and improve their codes over a seven-month period; advanced codes and computation—students have learned advanced programming techniques such as MPI from Challenge events.

The Challenge is also directly aiding in replenishing the essential scientific, engineering, and technical nuclear weapons pipeline and workforce (*Recommendation 7 of the Chiles Commission Report*) by stimulating the interest of and training in the discipline of computational science.

As a direct example, winning teams from the last four years have used a cluster of machines named "Theta" to solve their projects. Theta is a cluster of two SGI Origin 2000s, the same architecture as the Accelerated Strategic Computing Initiative, or ASCI, "Blue Mountain" machine (Fig. 2).

ASCI is a tri-laboratory and Defense Programs (DP) collaboration that will create the leading-edge computational modeling and simulation capabilities that are essential for maintaining the safety, reliability, and performance of the US nuclear stockpile and reducing the nuclear danger. Blue Mountain is a machine that assists in this mission and eliminates the need for underground nuclear testing.

Most importantly, October 2000 marked the beginning of the eleventh year of the Challenge. The Challenge staff has been proud to offer our services to communities of New Mexico during the past decade.

## Highlights of This Year's Accomplishments

### Analysis of Direct Impact on Laboratory

We took the Challenge student and teacher data from October 1990 through October 2000 and matched it up with the Laboratory's Employee Information System database. There are 209 matches of people who have been Challenge participants who also have been employed at the Laboratory at some time. Sixty-nine of those 209 are currently employed at the Laboratory.

*Figure 2. Overview of the ASCI Blue Mountain Supercomputer.*

**Kickoff Conference**
Over 300 participants gathered at the Glorieta Conference Center to begin the Challenge year. The Challenge was able to obtain Karen G. Haines, (a postdoctoral fellow from the Albuquerque High Performance Computing Center) to deliver the keynote speech. She presented an engaging discussion on her work entitled "Using Computational Science and Scientific Visualization to Model the Fly's Early Visual Processing."

**November School Visits**
During November, Challenge representatives from the Laboratory traveled to various high schools in Northern New Mexico to assist students and teachers with their projects. Individualized instruction was also provided in computer programming and Web design.

**Regional Workshops**
A great success this year was "Meet the Scientist Luncheon" at the regional workshops. Over lunch, local faculty members and scientists discussed teams' projects with them, offered suggestions, and lent support to ideas. Also of interest this year were computer ethic discussions—in particular issues concerning "free" music trading over the Internet.

**Promotion**
Several times during the year, Challenge coordinators attended conferences and workshops to promote the Challenge and encourage participation by others. Included this year were visits with the following groups: Mexican American Engineers and Scientists (MAES); Women in Science—Expanding your Horizons; Math, Engineering, and Science Achievement (MESA); and various state Chambers of Commerce.

**Awards Day Ceremony**
The Challenge competition came to a conclusion in April when about 150 participants came to Los Alamos. Laboratory scientists gave them tours that included scientific talks. Additionally, the participants were able to see the computers that they had been working on while viewing the Laboratory Data Communication Center machine room. Approximately 90 Laboratory personnel were involved with the activities in one way or another.

A team of three sophomore girls from Sandia Preparatory School won the top honors. An official Laboratory press release provided more details.

**Summer Teacher Training Session**
In June, a two-week-long Summer Teacher Institute was held at New Mexico Tech (NMT) in Socorro, New Mexico (Fig. 3). This event was sponsored in part by NASA and Tennessee State University.

Participating were over 20 teachers from around the state, receiving three units of graduate credit each from NMT. They were instructed in C++, Unix, HTML, and other topics.

**Year-Round Online Consulting**
Our set of online tutorials was expanded to cover more topics. More information on the Java programming language was added to provide step-by-step instructions for participants who wish to learn this language.

**Other**
The Challenge has had a positive impact on students, teachers, schools, and communities throughout New Mexico. As a result, the Laboratory's participation has had a positive effect on participants' perception of the Laboratory. Additionally, the Laboratory has been able to use the Challenge to promote good neighbor practices and received a lot of positive press coverage due to the Challenge.

The Laboratory and the other Challenge sponsors look forward to their contributions to the future participants and the world in which they will live.

*Figure 3. Teachers and staff at the Summer Teacher Institute at New Mexico Tech.*

# Developing Information Systems Careers (DISC)

## Program Description

The Developing Information Systems Careers (DISC) program targeted post-secondary students to improve both the applicant pool and the retention rate of information technology (IT) personnel at Los Alamos National Laboratory. DISC was developed to focus on the critical skill area of computing (computer support) for Los Alamos National Laboratory-Defense Programs missions in alignment with the Chiles Report. Upper level high school and undergraduate level students who demonstrated a desire and interest in the computing world were inducted into the Laboratory work force through internships and apprenticeships that lead to employment opportunities. Specifically, DISC addressed how to attract and induct people into the IT field, how to train them for the rapidly growing and advancing market, and how to support and retain them as Laboratory employees, once they are hired.

Program costs in FY01 were reduced through the development of collaborations with individual line organizations. Ninety percent of the student costs were borne by the line organizations. In addition, several Laboratory computing groups including Scientific Software Engineering (CCN-12), Desktop Group (CCN-2), and Customer Service (IM-2) provided technical speakers for student seminars. Ongoing efforts to recruit mentors and sponsoring organizations are continuing to build a strong network for the future. Through these efforts, a Laboratory principal investigator (PI) was identified, and development of the FY02 DISC proposal was completed. In addition, these efforts located other potential Laboratory PIs for the development of future proposals in the critical skill areas of high-energy fusion and high-performance computing.

## Performance Objective and Milestones

The DISC program was designed to (1) develop a diverse pool of candidates with computer skills to assist the Laboratory in building a talented work force to meet current and future needs, (2) increase student understanding and use of technology for telecommunications and research purposes, and (3) demonstrate how to solve simple to complex problems related to computer support efforts. Recruitment for the program focused on graduating high school students planning to attend two- or four-year colleges throughout northern New Mexico. Participants were selected based on their interest and aptitudes in IT work.

## FY01 Milestones

- Due to collaborative recruiting efforts with various LANL line organizations, thirty-three students were placed in computer science positions at the Laboratory during this past summer.
- Two students were placed in March and the remainder started in late May and early June.
- Students were introduced to life/work at the Laboratory through student orientation sessions held in June.
- Students were offered opportunities to learn about the computing world at LANL through seminars coordinated by the Education Program Office (EPO). Speakers included Robert Judd (CCN-12), William Robertson (IM-2), and Ben Martinez (CCN-2).
- One student was hired on permanently as a technical employee in the Communications and External Relations Division at the end of his summer internship program.
- Multiple students learned to use the Internet/

Intranet to obtain information for projects.
- One student took the initiative to obtain additional training in computer related courses.
- Students report that they have learned how to identify and solve complex problems.

The DISC program supported the Laboratory in the thirteen identified critical skill areas in the following ways:

- Sponsoring organizations received a continuum of high-quality computer technicians and computer science students who were motivated and able to contribute to the Laboratory's mission and program objectives.
- Students were matched with specific organizational needs and requirements.
- A population of New Mexico students was actively recruited and placed in the Laboratory's workforce pipeline.
- The program provided the Laboratory with the means to meet UC contract requirements to interact with local and regional communities.
- The program established a win-win relationship with students and line organizations.

## Highlights of This Year's Accomplishments

Funding was made available in mid-February and active planning and recruiting began in late February. A Laboratory PI, Dale Land, was identified to develop a DISC related proposal for FY02.

Student assignments focused on organizational requirements, the Laboratory's mission, and the critical skills areas. The students work assignments included computer system analysis, maintaining and troubleshooting computers and computer networks, desktop support, server support, computer network configuration, computer upgrades, computer security, hardware and software installations and configurations, systems and network administration, using test equipment, and conducting hardware diagnosis (Figs. 4 and 5). All students were assigned LANL mentors.

## Demographics

Table 1 and Charts 2 and 3 represent the breakdown of the participants by gender and ethnicity.

## Lessons Learned

Based on informal conversations with both students and mentors, a number of areas were identified that can be strengthened. These include more seminar workshops beginning in June, more social events, the need for workshops with mentors, and the need for working with local institutions of higher learning in recruiting.

*Figure 4. Carlos Martinez, STB/EPO.*

*Figure 5. Melissa Dubriel, HR T&D.*

**Table 1. DISC Gender and Ethnicity**

| **Student Gender Breakdown:** | Total 33 | 100% | | |
|---|---|---|---|---|
| Male | 23 | 69.7% | | |
| Female | 10 | 30.3% | | |
| **Student Ethnicity Breakdown:** | Afr-Am | Cauc | Hisp-Am | Native-Am |
| Male | 0 | 10 | 13 | 0 |
| Female | 1 | 1 | 8 | 0 |
| Percentages | 3.0% | 33.3% | 63.6% | |

These findings have led to the pursuit of a number of ongoing solutions. Efforts to identify sponsoring organizations and to identify effective mentors were started and are continuing for next year. Planning for recruiting and placement efforts are also underway for next year to ensure effective transition to implementation when funding is approved. Plans are being developed that will assist sponsoring line organizations in developing meaningful work experiences that capitalize on the student's knowledge and previous experiences. A collaborative effort is underway with the Education Program Office Student Program Liaison coordinator to develop a mentor workshop and support plan. Additional collaboration efforts are underway with the GRA (graduate student program) and UGS (undergraduate student program) coordinators to develop an enhanced student support system to improve the student's work and social environment, an important element in recruiting and retention efforts.

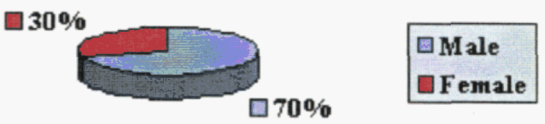



*Chart 2. Participants by gender.*

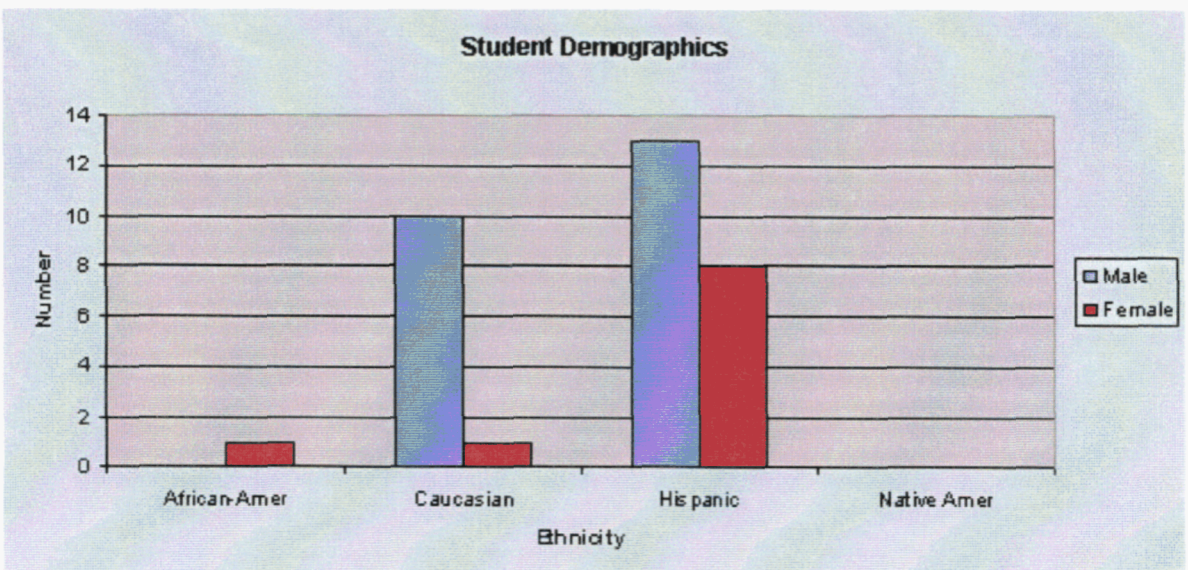



*Chart 3. Ethnic representation.*

## Survey Results

An anonymous survey administered in mid-August captured the following responses from both mentors and students.

### Comments from Mentors

*"The time involved (with mentoring my student) was well worth it when she expressed a heartfelt gratitude for what I had done for her during the summer."*

*"Never in my life did I expect such enthusiasm to come from a person so young."*

*"I had to curb (his) efforts to go beyond his assigned tasks. I felt that he needed to slow down and fully understand what we were doing. In the end he began to realize that we had to impose certain limits on what we can and cannot do here."*

*"Once she knew what our expectations were, she not only met them, she exceeded them."*

*"I'm not sure this is the type of job he should be pursuing, but if he wants to return next year I'd be more than happy to have him back. He was a great worker."*

### Comments from Students

*"I learned a lot this summer. I didn't know there was so much to working with computers."*

*"It was fun but I think next year I will try to get a job doing programming."*

*"I didn't know they did so much up here. It's kind of neat to say that I was working here."*

*"Working here this summer really helped me understand my college classes better."*

*"It exposed me to a lot of things going on around the Laboratory."*

*"I thought it was pretty interesting to see the work the Laboratory did."*


# *"Go Figure!"*
# A Celebration of Math

"We improve ourselves by victories over ourselves.
There must be contests, and you must win." – Edward Gibbon

## Program Description

The *Go Figure!* Mathematical Challenge is co-sponsored by Los Alamos National Laboratory and Sandia National Laboratories and funded by the US Department of Energy Defense Programs. The Challenge is dedicated to strengthening the mathematical capabilities of our nation's youth by identifying, recognizing and rewarding those students talented in mathematical thinking. Other goals include (1) engaging parents and the community in recognizing and supporting talented students, (2) engaging teachers in *Go Figure!* with the intent of stimulating them to be better math teachers, (3) engaging talented students and involving them with the Laboratories in summer internships or in other capacities so as to aid in their development and make their successful recruitment as professional staff members more likely, and (4) increasing the diversity of the Laboratories' pipelines by targeting students from underrepresented populations. It is hoped that by participating in the competition students will be reminded that mathematics and algebra are the building blocks for all the scientific disciplines and that without that foundation their career opportunities will be severely limited.

*Go Figure!* targets students from grades 7–12 in northern New Mexico and provides them the opportunity to participate in problem solving and enriching mathematical experiences. It is intended for everyone from the average student who enjoys mathematics to the very best student who excels in mathematics. The various recruitment strategies include site visits to the schools by the Laboratory program coordinator and Laboratory technical staff members, local radio and TV public service announcements, news releases in local newpapers and the Laboratory daily newsbulletin, and the *Go Figure!* website http://set.lanl.gov/programs/gofigure.

The contest is structured such that participants are offered 13 problems and two and one-half hours of time to solve them. Problems are selected that require for their solutions a minimal amount of knowledge and a great deal of creativity, originality, and analytical thinking. When the contest is graded, credit is given for supporting work, thus rewarding originality and creativity. Pre-registration is not offered, and there is no restriction placed on the number of participants from each school, for doing so would put schools in a position of deciding who will represent them, which would in most cases mean choosing "A" students, and not best talents, which is what the contest seeks.

## Performance Objective and Milestones

The performance objectives of *Go Figure!* focus on enhancing the supply of well-qualified mathematicians, especially at the Laboratory, by

providing tools and resources to prepare students for induction into the workforce pipeline. This objective is met through (1) tracking educational and career aspirations of program participants via a database and ongoing communications; (2) inviting Laboratory technical staff members and technicians to attend workshop activities, thus promoting positive relationships and exposing the students and parents to a larger network of scientific knowledge; (3) developing a program summer internship component; and (4) recruiting the most promising students into the Laboratory pipeline.

The program purpose is to create a renewed interest in mathematics in northern New Mexico by encouraging student confidence in mathematics and to foster connections between content knowledge of math and its applications in the area of national security. Many students first develop an interest in mathematics through problem-solving activities such as *Go Figure!* Through the development and promotion of such programs, an improvement in the attitudes of teachers, students, and their parents toward the ability to understand and apply mathematics is expected to take place. To that end, FY01 saw *Go Figure!* expand its official contest locations to include Cuba Middle School and Española Middle School.

In addition to expanding this past year to include a broader geographical area, the program strengthened its involvement with the Northern New Mexico Council for Excellence in Education's (NNMCEE), MSA as a recruitment avenue for promoting the contest. The association with the MSA is, by all accounts, a positive influence on *Go Figure!*

Throughout the *Go Figure!* experience over the past three years, students and teachers have developed a Web-based communications network with the intent of creating a strong educational support network among the participants and their surrounding higher-learning institutes, such as the Laboratory and San Juan College. Students are encouraged to take practice tests and view previous years' exams on the *Go Figure!* website, in order to better prepare for the contest.

## Highlights of this Year's Accomplishments

This past year also saw an increased collaboration between the sponsoring Laboratories—Los Alamos National Laboratory and Sandia National Laboratories. The Los Alamos staff wishes to thank their colleagues at Sandia for helping to identify appropriate technical staff members to serve as proctors and graders. This collaboration resulted in Dr. Madhav Marathe, D-2, the Basic and Applied Simulation Science Group at the Laboratory, serving as a proctor for the October 27, 2001 Challenge.

The successful Four Corners *Go Figure!* Mathematical Challenge was held on October 27, 2001, with 68 participants spanning the seventh through the twelfth grades. The contest was held at San Juan Community College in Farmington, New Mexico, Los Alamos Middle School, Española Middle School, and Cuba Middle School. Los Alamos National Laboratory sponsored all four sites. Contest participants accepted the challenge of a two-and-half hour test on problems that ranged from easy to very difficult. Most enjoyed the contest and found it mentally stimulating and challenging. A banquet honoring the winners of the contest was held on November 15, 2001, in Farmington with the highlight of the evening being a presentation by Vernon Willie, a professor at San Juan Community College. The banquet was well attended by students, teachers, and parents.

The following books were awarded as prizes to the winning students from each grade level for their achievements in the 2001 *Go Figure!* Mathematics Challenge:

> "*Enjoyment of Mathematics: Selections from Mathematics for the Amateur*," by Hans

Rademacher and Otto Teoplitz, IBSN 0-691-02351-4.

"*What is Mathematics? An Elementary Approach to Ideas and Methods*," 2nd Edition, by Richard Courant et al., ISBN 0-19-510519-2.

"*Mathematical Discovery, Combined Volume*," by George Polya, IBSN 0-471-08975-3.

"*How to Solve It,*" by George Polya, IBSN 0-691-02356-5.

"*Number Theory and Its History,*" by Oystein Ore, ISBN 0-486-656209-9.

"*The Wohascum Country Problem Book,*" by George Gilbert et al., ISBN 0-88385-316-7.

As in previous years, Dr. Abraham Hillman was an invaluable contributor to the development, implementation, and success of the FY01 *Go Figure!* Challenge. It is important to capture the essence of Dr. Hillman's pedagogy in the planning, grading, and recruiting in order to improve the implementation of this effort as it grows in popularity.

On August 14, 2001, 38 winning students from the November 4, 2000, *Go Figure!* Challenge were invited to Los Alamos to participate in a *Go Figure!* Enrichment Day. The day began with tours of the Los Alamos Historical Society Museum and the Bradbury Science Museum where the students furthered their knowledge of the history of the Laboratory and examined project displays that convene some of the mathematical research conducted at the Laboratory. Following the tours, they lunched with representatives of the Laboratory's Educational Program Office (EPO) and Dr. Madhav Marathe and other invited mathematicians from the Laboratory. Lunch was followed by a roundtable session where Dr. Marathe led an interactive discussion on theoretical mathematics at the Laboratory and challenged the students to accept his invitation to serve an internship under his mentorship next summer. The day concluded with the students attending two mini-sessions taught by EPO staff. The sessions instructed them about how to build an educational Website, informed them about the various student opportunities at the Laboratory, and taught them how to recruit students at their schools for the next *Go Figure!* Challenge to be held in October 2002.

Future recruitment for *Go Figure!* will be enhanced by a video that Vernon Willie, mathematics professor at San Juan Community College in Farmington, is planning to produce in FY02 in conjunction with students at a school in the Four Corners area.

## Comments from Participants

*"I really enjoyed the LANL Go Figure! Day. Madave Marathe was an excellent speaker and for the first time I understand why math is so important!"*

*"The tours at LANL were great. I enjoyed the Bradbury Science museum and having lunch with other students and scientists at the Los Alamos National Laboratory. I felt important."*

*"I have been involved in a lot of math competitions but this contest is great, and I got to come to the Los Alamos National Laboratory for a day."*

*"Professor Vernon Willie's talk at the banquet was really good and showed us how math is used in everyday things like the nautilus shell."*

*"The books we got for awards for the Go Figure! contest were good books on math. I shared them with my sisters and brother at home, my math class at school, and students in my math club."*

## Comments from Parents and Teachers

*"After hearing from Madave Marathe, technical staff member at LANL, we went back to Farmington and demanded a more rigorous math curriculum for our students so they can better succeed in college and in life."*

*"Mr. Vigil came into our math classes and did a great job recruiting for the upcoming Go Figure! Math Contest. The students enjoyed his hands-on presentation style."*

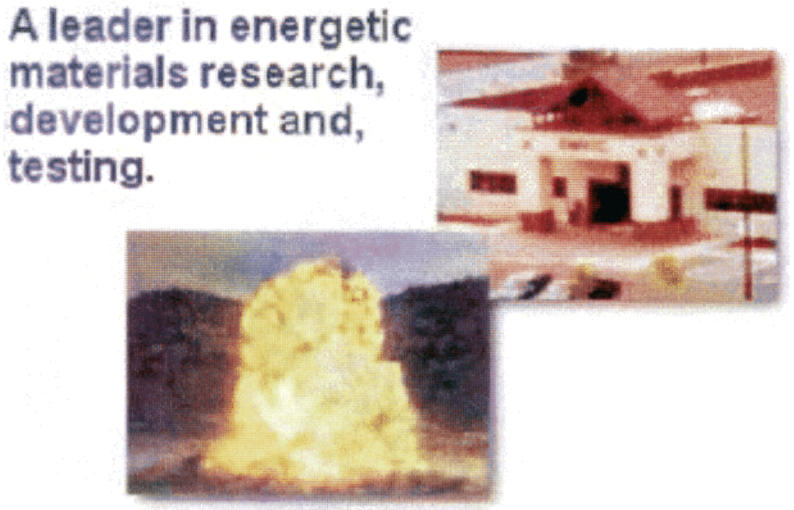
*"I have worked with Go Figure! for three years and the program gets better and better. Thank you DOE/DP and Los Alamos National Laboratory."*

*"Thank you so much for the nice banquet honoring my students. The students here are not my best students but are solid students, who with this recognition, could become top-notch math students and could go on to college and excel in mathematics."*

*"I am so proud of mi hita. We love her very much and want the best for her. I want her to do better than I did in school. Thanks for your support of our children."*

*"The food was good, and the talk by Vernon Willie was very interesting and cultural. I would like to meet this Professor Abe Hillman and shake his hand."*

# High Explosives Training Program




## Program Description

The purpose of the High Explosives (HE) Training program is to revitalize the high-explosives engineering and manufacturing technical knowledge base at the Laboratory. This skill set has dwindled because of a decade of inactivity in refreshment of a stockpile that was built on a continuous 10 to 20 year cycle. Within the Engineering Sciences and Applications Division, the Weapons Materials and Manufacturing (ESA-WMM) group, is responsible for processing, fabricating, and disposing of energetic materials used in the nuclear weapons program. Each year the group makes roughly 1500 high-explosive components for research and development and test programs. The technical staff and mechanical technician workforce responsible for making these components is nearing retirement, and there is an urgency to maintain this critical skill. Without immediate and precise intervention, this critical skill will be lost to Los Alamos. There still exists the opportunity to utilize those nearing retirement in building a training program and mentoring the future generation of high-explosives engineers.

While the work force is aging (the average technician is 45 years old), the programmatic need for the development of high-explosive components to support the nuclear weapon SLEP (Stockpile Lifetime Extension Program), stockpile management, and fundamental research is growing. In the next five years, ESA-WMM expects to hire four to six high-explosives technicians and three to four high-explosives engineers. The talent to fill these processing positions exists in area universities, vocational training programs, and other educational institutions, but there does not currently exist a program in which this talent can be trained before prospective employees are on the job. The objective of this program is to recruit these individuals to Los Alamos and rapidly train them to become contributors to the weapons program.

The current focus of this program is for newly hired and upcoming new hires on the high-explosives team to become trained in the characteristics, handling, processing, manufacturing, and disposal of energetic materials. It is hoped that this effort, with the support of local educational institutions, will soon provide programs that will award educational degree programs for individuals interested in the various aspects of energetic materials.

The program is currently targeted toward individuals that have already been hired by the Laboratory. Those interested must have at least a high school degree and some college work in physics and chemistry. We are working with New Mexico Tech in getting some of our employees involved with their new master's degree in explosive engineering through the Mechanical Engineering Department. There are also plans to develop a doctorate degree in energetic materials within the same department in the near future.

A very critical program we are also working toward is a certificate or associate's degree in high-explosive handling and processing. This program is being developed through the Mining Engineering Department at New Mexico Tech. New Mexico Tech operates the internationally known Energetic Materials Research and Testing Center (EMRTC). This facility is known for their anti-terrorist work with explosives. EMRTC is currently building facilities in Socorro, New Mexico, to house equipment and machinery for the manufacturing and processing of high explosives. ESA-WMM is currently gifting to EMRTC several pieces of equipment to be used for this purpose through a Laboratory Educational Equipment Gift (LEEG) agreement. As other Laboratory equipment is replaced or becomes obsolete for our needs, EMRTC will have the opportunity to receive future pieces of equipment for high-explosive processing. EMRTC will then have the ability to train individuals in high-explosive machining, and the Laboratory will be able to offer these individuals employment opportunities.

The current opportunities with New Mexico Tech have been advertised within the ESA and Dynamic Experimentations Divisions. We had hoped to start with a small population to first work out the problems with distance education. Word spread rapidly to Lawrence Livermore National Laboratory (LLNL), Pantex, and DOE, and we now have over one hundred interested individuals. Once other programs are fully developed, we expect more participation from technicians and in other areas of the Laboratory. So far, word-of-mouth and e-mail have been the only advertising methods used.

## Performance Objective and Milestones

Our main goal, which can be divided into two main objectives, is to re-establish Los Alamos as the technical knowledge base for the engineering and manufacturing of high explosives. First, we wish to train newly hired chemical and mechanical engineers in the field of HE engineering and manufacturing. New Mexico Tech currently offers a graduate degree in high explosives engineering that may be tailored to the needs of the DOE nuclear weapons program. A similar program is currently taking place at Sandia-Albuquerque through their Weapons Intern Program. With a combination of New Mexico Tech classes, some Sandia weapons classes, and some of our own classes taught by valuable members of our staff, it would be possible to award a degree program or a certificate through New Mexico Tech that would show that the graduate had the needed knowledge to "*hit the floor running*" once the program is completed. New Mexico Tech students already involved in the graduate program may also be recruited and trained as high explosives engineers in a program tailored to the needs of Los Alamos and the weapons program.

The second objective for the program is the development of an associate's degree or certificate in high-explosives manufacturing from which the Laboratory and DOE complex can recruit vocational graduates to support the manufacture of research and development parts. There are many machinist-training programs, but there are no formal apprentice programs in the field of high-explosive safety, pressing, casting, machining, inspection, and disposal. Other facilities, such as the Naval Air Warfare Center, are watching our progress in this area with great interest, as they are facing the same attrition problem. The gifting of our excess equipment

will allow EMRTC and New Mexico Tech to develop classes to support these skills.

## Milestones Proposed and Met this Year

- Formation of a steering committee from the Laboratory and New Mexico Tech. This committee began meeting in April 2001, and meets about every two months.
- Curriculum finalized. Various curricula have been proposed and discussed, but none have been finalized because we are not confident of the support we will receive. Management seems to be concerned with time commitments for both students and instructors. Therefore, we have currently decided to continue with a few classes at a time. New Mexico Tech does not require a commitment to a degree program until after twelve credit hours have been taken.
- Students, mentors, and instructors identified. We have identified over one hundred students and instructors for two classes that will be taught in the spring by New Mexico Tech.
- Distance education media operational. With the tremendous help of HR-6, we know that we can effectively and efficiently communicate with New Mexico Tech through video conferencing.
- Development of a safety course with EMRTC. The curriculum of a safety course with the help of EMRTC was developed, and the course was given in late September. Two days of instruction were given at the Laboratory with the help of our "*forefathers*," such as John Ramsay and Bill Davis, followed by two days at the firing site at EMRTC with a series of hands-on fieldwork. Twenty people from the Laboratory attended, as well as one local high school teacher.
- Donation of processing equipment to New Mexico Tech through the LEEG Program. EMRTC personnel were brought to the Laboratory to select desired equipment. All Laboratory paperwork has been completed. Equipment is currently being prepared for removal and transportation to EMRTC.

ESA-WMM plans to take a proactive approach to staffing the R&D manufacturing line for the coming years by partnering with NM Tech in building graduate, undergraduate, and associate's-level degree programs. Science-based stockpile stewardship requires the transfer of decades of experience and knowledge to a new generation of scientists and engineers who can apply new tools and technology. Stewardship of the manufactured high-explosive components requires a thorough understanding of what was proven through testing and the processes used to make them at Los Alamos.

The high-explosive components certified through a series of underground tests, hydrotests, and mechanical tests were manufactured at Los Alamos. Coincident with performance questions, there are increasingly more difficult questions being asked about the safety of explosive components for weapon systems under extreme conditions. These questions can only be addressed if the scientific expertise is transferred from the original explosives engineers to a new generation of engineers. What took a career for the present engineers to understand must be transferred in a few short years. The time is too short to pass the torch through on-the-job training, so a formal education approach is necessary to revive this critical skill. When established, LLNL and Pantex could utilize this educational program for staff development and recruitment as well. DP-sponsored research in shock physics will also benefit from this program.

This program addresses at least two of the Critical Skill Areas for Stockpile Stewardship: #4, Materials Science and Technology, and Critical Skill Area #6, Manufacturing. More specifically, the program outlined will provide special expertise in HE, including mechanical and thermal characterization, as well as compatibility issues, weapons materials processing, fabrication, testing and evaluation, and increased knowledge in HE safety and performance testing and analysis. There will also be the development of expertise in the areas of manufacturing

process development, component fabrication, inspection, and assembly. The education will focus specifically on explosives used in the DOE complex and fielded nuclear weapons. The advanced degrees will also develop an expertise in other critical knowledge areas such as shock and detonation physics (Skill Area #2) and design, fielding, and execution of dynamic experiments (Skill Area #7).

## Highlights of This Year's Accomplishments

This program did not get underway until April 2001. Since that time we have established a distance learning committee with New Mexico Tech, which also includes an interested member from Livermore. We have support from division management and from HR-6. We are determined to make this program a first-class operation.

We developed and presented with EMRTC a safety course on high explosives. Two other groups [Dynamic Experimentation firing site teams and NESS (Nuclear Explosives Safety Study)] are currently requesting that we develop and deliver a similar course for their organizations, with an emphasis on their interests and needs.

Two classes offered by New Mexico Tech next spring have been advertised within two divisions at the Laboratory with tremendous response. We are also trying to determine if our distance education facilities will also support Livermore and the Nevada Testing Site as well.

We are in the process of donating over $300,000 worth of equipment to EMRTC to establish a center for high-explosive manufacturing and processing training. Other equipment should become available in the future as we replace some of our presses.

# Los Alamos Dynamics Summer School

## Program Description

Over the last 20 years there has been a 20% decline in the number of engineering degrees granted while university degrees in general have increased approximately 20%. Engineering dynamics, which encompasses areas such as flight dynamics, vibration isolation for precision manufacturing, earthquake engineering, blast loading, signal processing, experimental modal analysis, etc. is naturally affected by this decrease in numbers. The effects of this trend are even more pronounced when one considers that most engineering dynamics positions at national laboratories require advanced degrees and are limited to US citizens. Currently, approximately 35% of engineering master of science (MS) and 50% percent of engineering graduate school students are foreign nationals.

The competition for talented individuals with the background necessary to replace those leaving the field of engineering dynamics necessitates a proactive approach of identifying, motivating, and educating students who are embarking on their graduate school careers. The Los Alamos Dynamics Summer School was designed with this proactive approach in mind. The program is designed not only to benefit the students through their educational experience, but also to motivate them to attend graduate school and to make the students aware of career possibilities at DOE laboratories after they have completed their graduate studies.

The summer school has two focus areas. First, the multidisciplinary nature of research in engineering dynamics is emphasized throughout the summer school. To this end, the students were assigned to diverse teams and given a project where a coupled analytical/experimental approach to dynamics problems is required. Second, the program is designed to develop the students' written and oral communications skills. To develop these skills, the students were required to give numerous informal oral presentations of their work as it progressed throughout the summer and culminating in a formal presentation and a paper written for the International Modal Analysis Conference.

### Student Body Profile

This program primarily targets university juniors and seniors who have achieved sufficient academic success to be credible candidates for graduate school. First-year graduate students are also targeted for this program. The summer school was taught for the second time in the summer of 2001 to twelve students. Two of the students have completed their first year of graduate school, two are starting graduate school in the fall, and eight will be seniors next year. The students were mostly mechanical (9) or civil engineering majors (2), and there was one aerospace engineering major. Two of the students were women or underrepresented minorities. The grade point average (GPA) for the students was 3.6 on a scale of 4.0. Undergraduate institutes that were represented by these students included Rose-Hulman Institute of Technology, Case Western Reserve University, University of Houston, Purdue University, Colorado State University, University of California-Irvine, Montana State University, and Texas Tech University. Graduate schools represented by these students (where they currently attend or will attend in the Fall) include Texas Tech University, Purdue University, Cornell University, and University of Wisconsin-Madison.

### Program Projects

The centerpiece of the summer school was an eight-week project having both an analytical and

an experimental component. The experimental component was a critical aspect of the program because practical experimental activities in engineering dynamics are almost nonexistent at the undergraduate level. Students were placed in teams of three people and assigned a project. An attempt was made to make the teams as multidisciplinary and diverse as possible. To this end, students from the same school were not assigned to the same team. Each team had a mentor from Los Alamos National Laboratory or Sandia National Laboratory technical staff. The mentors worked closely with their groups providing guidance, encouragement, and technical expertise. All of the projects resulted in papers to be presented at the 2002 International Modal Analysis Conference. The titles of the resulting papers and their abstracts are listed below.

**Effects of Bearing Surfaces on Lap Joint Energy Dissipation**

Abstract: Energy is dissipated in mechanical systems in several forms. The major contributor to damping in bolted lap joints is friction, and the level of damping is a function of stress distribution on the bearing surfaces. This study examines the effects of bearing surface configuration on lap joint energy dissipation. The examination is carried out through the analysis of experimental results in a nonlinear framework. Then nonlinear finite element models are constructed to simulate the results. The experimental data were analyzed using piecewise linear log decrement. Phenomenological and nonphenomenological mathematical models were used to simulate joint behavior. Numerical results of experiments and analyses are presented. The lap joint studied is shown in Fig. 6.

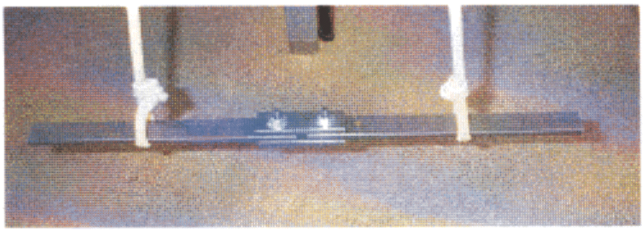


*Figure 6. Lap joint studied.*

**Experimental Modal Analysis and Damage Detection in Simulated Three-Story Building**

Abstract: This is a continuation of the paper entitled "Damage Detection In Building Joints By Statistical Analysis" in which accelerometer data were acquired from a simulated three-story building driven by an electrodynamic shaker attached to the base of the structure. Joint damage and environmental conditions were simulated, and data were collected systematically for comparison. Operational variability was introduced by changing the shaker input amplitudes and frequency ranges. A damage-sensitive feature was extracted from the data and a sequential probability ratio test (SPRT) was used to determine when this feature changed as a result of damage. The test was shown to be sensitive to the operational variability and other sources of variability. This investigation was conducted as part of a conceptual study to demonstrate the feasibility of detecting damage in structural joints caused by seismic excitation. A picture of the instrumented structure is shown in Fig. 7.

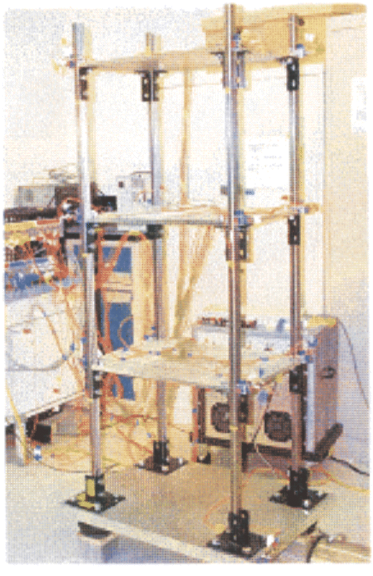


*Figure 7. Simple model of a three-story building.*

**Instrumented 5-DOF System Identifying the Effects of Stiffness Changes in a 5-DOF System**

Abstract: Using a system of five masses and four springs, both linear and nonlinear changes in

stiffness were detected by examining the frequency and time response of the system. The replacement of an individual spring with one of a different stiffness value created a linear change, while nonlinearities were introduced through the use of collisions between masses. From the time history of the input force and the accelerations of each mass, the frequency response functions, natural frequencies, mode shapes, power spectra, and probability density functions were calculated. These results were used, in conjunction with a numerical model, to detect changes in the system. In general, the natural frequencies and mode shapes were the best identifiers for linear changes, while the power spectra and probability density functions best identified nonlinear changes. The 5-DOF structure is shown in Fig. 8.

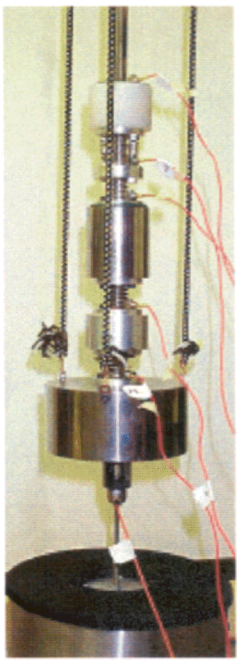


*Figure 8. Instrumented 5-DOF system.*

**Passive Modal Damping with Piezoelectric Shunts**

Abstract: The use of piezoelectric materials in conjunction with passive inductance-resistance-capacitance (RLC) circuits to dampen specific vibration modes is explored. The piezoelectric materials convert mechanical energy to electrical energy, which is then dissipated in the RLC circuit through joule heating. An impulse is applied to a simple cantilevered beam and by varying the inductance and resistance values, the natural oscillation frequency for the RLC circuit is tuned to dampen the first mode of vibration. Pictures of the beam and PZT material are shown in Fig. 9.

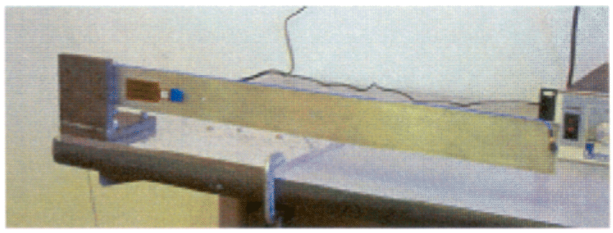


*Figure 9. Aluminum beam with piezoelectric shunt.*

**Experimental Equipment and Software**

Students each had their own high-end PC with numerical analysis and signal processing software. The companies donating software are shown in Table 2.

Each research group had access to a multichannel data acquisition system. Finite element analysis software was made available to each research group as necessary. Equipment on hand at the start of the summer school included

**Table 2. Companies Donating Software for the Duration of the Summer School**

| Company | Software | Purpose |
|---|---|---|
| Mathworks | Matlab (plus all toolboxes and simulink) | Numerical analysis and signal processing |
| Ansys, Inc. | ANSYS | Finite element analysis |
| Vibrant Technology, Inc. | ME'scopeVES | Vibration data analysis |

- 14 PCs with MS office and numerical analysis and signal processing software.
- 40-channel HP data acquisition system (Fig. 10), 4-channel Dactron Photon dynamic signal analyzer, two 8-channel Dactron SpectraBook data acquisition systems. (The Photon and one of the SpectraBooks were donated by Dactron for the duration of the summer school.)
- Data acquisition/signal processing software
- Experimental Modal software packages (ME'scopeVES)
- Various sensors, impact hammers, and small shakers were acquired for specific projects
- Finite element software (ANSYS)
- Rigid-body dynamics software package (ADAMS or Working Model)

**Field Trips**

Several field trips were taken throughout the summer. These trips included tours of the Aging Aircraft Facility, Robotics Facility and Micro-Electromechancial Systems Facility at Sandia National Laboratory. Another field trip to see a rocket sled test at Holloman Air Force base was scheduled for the last week of the summer school, but was cancelled because the test was postponed at the last minute.

**Visiting Distinguished Lecturers**

Each week a prominent guest lecturer in the field of engineering dynamics gave a talk to the students about "cutting edge research" in structural dynamics. These lecturers and the titles of their talks are listed in Table 3. Most of the lecturers spent two to three days in Los Alamos. In addition to one formal presentation to the students, visiting lecturers spent time with the students discussing their projects and providing suggestions and additional motivation.

**Tutorials**

In addition to the project and the lectures by, and interaction with, the visiting distinguished scholars, the students received instruction on a variety of topics in engineering dynamics. This instruction took the form of multi-lecture tutorials on general topics such as random vibrations or computational structural dynamics and demonstration/application lectures on more specific topics. The titles of the multi-lecture tutorials are listed in Table 4 and the demonstration/application lectures in Table 5.

**Recruiting Strategy**

At the onset of the summer school we let the students know that one of the prime reasons for our investment in the summer school was the

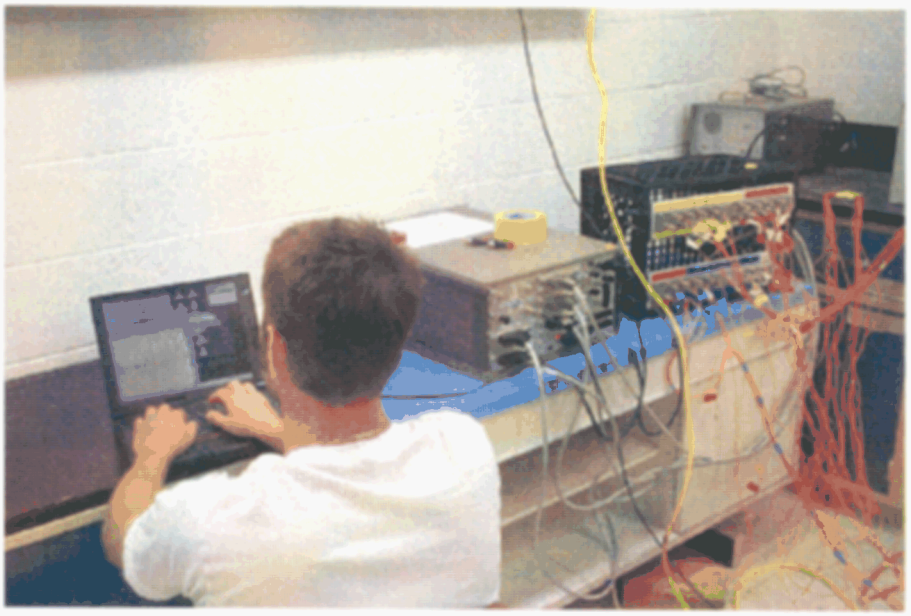


*Figure 10. The 40-channel data acquisition system.*

**Table 3. Distinguished Lecturers**

| Name | Title, Organization | Title of Talk |
|---|---|---|
| Dave Brown | Professor of Mechanical Engineering; Director of the Structural Dynamics Research Laboratory, University of Cincinnati | "Modal Analysis Case Histories" |
| Dave Ewins | Professor, Director of Center of Vibration Engineering, and Director of the Rolls-Royce University Technology Center for Vibrations, Imperial College, UK | "Vibration Testing in 2001: Who needs vibration tests in this age of supercomputers" |
| Dan Inman | Director of Center for Intelligent Material Systems and Structures; George R. Goodson Professor of Mechanical Engineering, Virginia Tech | "Smart Structures, Structural Health Monitoring and Control" |
| Tom Kenny | Associate Professor of Mechanical Engineering, Head of the Micro Structures and Sensors Lab, Stanford University | "Micromechanical Devices for Biological Force Measurements" |
| Gerry Pardoen | Professor of Civil and Environmental Engineering, President of the Consortium of Universities for Research in Earthquake Engineering, University of California, Irvine | "Earthquake Engineering" |
| Mike Todd | Head of the Naval Research Laboratory Fiber Optic Smart Structures group | " High-Performance Fiber Optic Sensing" |
| Geof Tomlinson | Professor; Director, Division of Aerospace Engineering; Director of Research, Engineering and Physical Science Division, University of Sheffield, UK | "Novel Materials/Devices with Application to Vibration Control" |

recruitment aspect. We also had several students from the 2000 school discuss their experiences with the school and explain to the new students why they decided to return to the Laboratory the following summer.

Our first goal in the recruitment of these students is to get them to return as graduate research assistants (GRAs) in the summers after they have completed the school. This summer we had five students from the 2000 summer school return in this capacity. Two other students wanted to return, but their advisors required them to stay and work on research projects at their respective universities. Two of the students that did return are spending a year at the Laboratory before they continue on with their graduate studies. The key to the students' return is to stay in contact with them after they return to their universities. In this respect, sponsoring the students to attend the International Modal Analysis Conference is optimal because the conference takes place in early February. We then get to meet with the students and discuss their plans for the upcoming summer. Also, we make it clear to the students that we will write letters of recommendation for them regarding applications to graduate school and applications for graduate fellowships.

**Table 4. Titles and Presenters of Multi-lecture Tutorials**

| Title | Presenter | Title, Organization | Number of Lectures |
|---|---|---|---|
| Rigid Body Dynamics | Phillip Cornwell | Associate Professor, Rose-Hulman Institute of Technology | 4 |
| Structural Dynamics | Nick Lieven | Reader in Dynamics, Head of the Dynamics and Controls Group and Director of Research for the Department of Aerospace Engineering, Bristol University, UK | 5 |
| Experimental Modal Analysis | Pete Avitabile | Assistant Professor of Mechanical Engineering; Founder and President of Dynamic Decision, University of Massachusetts, Lowell | 5 |
| Signal Processing | Norm Hunter | Staff Member, Los Alamos National Laboratory | 3 |
| Wavelets | Amy Robertson | Staff Member, Los Alamos National Laboratory | 2 |
| Controls | Matt Bement | Staff Member, Los Alamos National Laboratory | 2 |
| Random Vibrations | Tom Paez | Staff Member, Sandia National Laboratory | 5 |
| Nonlinear Vibrations | Doug Adams | Assistant Professor, Purdue University | 5 |
| Computational Structural Dynamics | Joel Bennett | Staff Member, Los Alamos National Laboratory | 5 |

**Table 5. Additional Instruction**

| Title | Presenter | Title, Organization | Number of Lectures |
|---|---|---|---|
| Confinement Vessel Blast Analysis | Bob Stephens | Staff Member, Los Alamos National Laboratory | 1 |
| Satellite Testing and Analysis | Tom Butler | Staff Member, Los Alamos National Laboratory | 2 |
| A Rigid Body Dynamics Code – ADAMS | Scott Doebling | Staff member, Los Alamos National Laboratory | 1 |

If the student is graduating with an M.S. degree or higher within the next year and our group has an opening, or we are aware of other openings at the Laboratory, we arrange an interview for that individual and corresponding group leaders to discuss possible employment. This approach proved successful this year, as we have recruited the first two staff members from the summer school.

It will take another two years before we will have a consistent stream of candidates to place. This delay is directly related to the fact that most students to date have just completed their junior year. This stage of their academic careers is the ideal time for the summer school to impact their decision to attend graduate school. Students at this stage of their careers have another year at the undergraduate level and then approximately two years to complete their M.S. degrees before they become eligible for hire.

## Performance Objectives and Milestones

**The original performance objectives were:**

- Design an eight-week program for a group of 12 upper division, US citizen, undergraduate or first-year graduate students.
- Identify high-quality students from diverse (human/academic) backgrounds.
- Recruit students from universities that emphasize undergraduate education as well as research institutes.
- Seek students from a variety of academic disciplines including aerospace engineering, civil engineering, mechanical engineering, and electrical engineering; computer science; and mathematics/statistics.
- Expose students to the multidisciplinary aspects of structural dynamics through analytical/experimental research projects.
- Develop students' written and oral communications skills.
- Make students aware of career possibilities at DOE DP laboratories.
- Require students to provide written feedback regarding their experiences during the summer school.
- Provide Los Alamos National Laboratory and DOE education programs offices with an annual summary of the summer school and its demographics.
- Maintain an "alumni database" to track the careers of the summer school participants over the next few years. The information contained in this database will be used to quantify the success of the summer school in meeting its intended goals of motivating the students to attend graduate school and pursue careers at DOE DP laboratories.

**The milestones identified in the original proposal were met.**

- End of November 00
  Obtain DOE funds for FY01 summer school and begin to recruit students.
- End of January 01
  Identify and receive commitments from lecturers, obtain approval for field trips and identify student projects and required equipment/test items.
- End of February 01
  Host student paper session at International Modal Analysis Conference. Identify students for FY00 summer school.
- End of March 01
  Obtain space allocations for summer school. Obtain matching funds and in-kind support.
- End of May 01
  Obtain necessary hardware and software for FY01 summer school.
- Mid June 01
  FY01 summer school.

Of particular significance was the in-kind support provided by leading software and hardware suppliers. MathWorks and ANSYS provided software that would have cost over $100K and Dactron provided data acquisition equipment that would have cost over $30K. These software and hardware donations were crucial to the success of the summer school. Also, the Engineering Science and Applications Division (ESA Division) provided 14 new PCs for the summer school at a cost of over $90K as well as $75K in direct financial support to cover staff members' time while they mentored the students. The Weapons Response Group in ESA provided administrative support, essential to the success of the summer school.

The organizers of the International Modal Analysis Conference (IMAC) have set up a special session for our students to present their papers at the 2002 IMAC Conference. We have obtained support from the Laboratory and the students' various schools so that all the summer school students can attend the IMAC Conference.

## Performance Measures

As summarized in the program description, program objectives and milestones originally

defined for this program have been met. The guest lecturers provided oral feedback on the student projects and overall administration of the summer school. This feedback was overwhelmingly positive.

Students were required to provide written feedback regarding their experiences in the summer school program. This written feedback included evaluations of each speaker, field trips, guest lecturers and a final overall evaluation of the summer school. The assessment of each speaker and guest lecturer will be used to decide which speakers to invite back next year as well as to give the individual speakers suggestions on how they can improve their contribution to the summer school. Overall the distinguished lecturers were rated highly with an average score of 4.2 and a median score of 4.4 on a scale from one to five where a one is "poor" and a five is "excellent." One speaker, who the students felt was giving a sales pitch for his own research, pulled down the average score for the distinguished lecturers. The average rating of the speakers giving the week-long lecture series was a 4.4, and the average rating for the speakers who gave just one or two lectures was 4.0. The field trips to the Aging Aircraft Facility, the MEMs Facility and the Robotics Facility at Sandia National Laboratory received ratings of 4.33, 4.78 and 4.33 respectively using the same scale discussed earlier. The average rating of the mentors was a 4.2. The mentors are listed in Table 6.

A summary of the final overall survey is shown in Table 7. Clearly from Table 7 the program benefited students educationally as well as motivating students that had not already decided on attending graduate school to do so. The goal of making students aware of career opportunities at Los Alamos in hopes of recruiting them upon graduation was realized when all 12 of the students indicated a desire to return to the Lab in subsequent summers as graduate research assistants, although several recognized this would probably not be possible due to commitments in graduate school. The fact that all 12 students would encourage someone they know to apply to the program next year is a clear testimony as to how positively the students viewed the program. As can be seen from Table 7, the average overall rating of the summer school was a 4.75. When the students were asked to rate the quality of the teamwork in their groups, three of the groups averaged a score of 4.7, and the final group had an average of 4.0.

## Student Comments

*"The project was really interesting and I feel that I learned a lot."*

*"I would just like to say thank you for this fantastic opportunity. I think that the summer school has been a very beneficial experience for all of us. I also think that the summer school's intention of drawing more people to work for the lab has been a success. Keep it up!"*

*"The DSS was an excellent opportunity to see into a field that is not talked about a whole lot in college."*

*"Working in Los Alamos has inspired me to do extra work on subjects I wouldn't otherwise cover in school. I am encouraged by the fact that*

**Table 6. Mentor Summary**

| Mentor, Affiliation | Area of Expertise |
|---|---|
| Amy Robertson, ESA-WR | Signal processing and system identification |
| Chuck Farrar, ESA-WR | Structural health monitoring |
| Norm Hunter, ESA-MT | Environmental testing and system processing |
| Tom Paez, Sandia National Lab | Random vibrations |

**Table 7. Assessment Summary**

| Question | Average rating |
|---|---|
| As a result of the program your knowledge and experience in experimental vibrations: (5 –Increased a great deal, 3 – Increased slightly, 1 – Stayed the same) | 4.83 |
| As a result of the program your knowledge and experience in analytical methods in vibrations: (5 –Increased a great deal, 3 – Increased slightly, 1 – Stayed the same) | 4.75 |
| Prior to the program if you had not already decided to go to graduate school did this program influence you to do so? (If you are already in graduate school or are attending one in the fall please leave blank) | 1 yes, 0 no,<br>1 "I'm strongly considering it"<br>10 already decided |
| Would you encourage someone to apply next year? | 12 yes, 0 no |
| Would you be interested in coming back to LOS ALAMOS NATIONAL LABORATORY as a Graduate Research Assistant next summer if a position was available? | 9 yes, 3 yes (but won't be able to), 0 no |
| Overall rating of the summer school?<br>(5 – Excellent, 4 – Very good, 3 – Good, 2 – Fair, 1 – Poor) | 4.75 |

*a civil engineering graduate can work on some exciting things in Los Alamos that wouldn't normally be offered to a beginning civil engineer, and I am certain now that I would like to continue school, and do research on dynamics of structures."*

*"A wonderful experience, I enjoyed all the guest and tutorial lectures."*

Even though the overall assessment of the program was overwhelmingly positive, there were a number of suggested improvements. These included

- Reduce overlap in some of the lectures
- Have more field trips
- Provide more information before the summer school begins
- Have more "real world" applications in the tutorials

In the assessment of the 2000 summer school the students made comments concerning reordering of the lectures, changing the lecture times, and the limited or mildly inadequate experimental or computer equipment. Because students did not comment on these topics this year, we feel that changes made to the program adequately addressed these concerns.

## Critical Skills and DOE/DP Mission Benefit

We proposed this summer school concept because engineering dynamics is an integral part of the Laboratory's nuclear weapons stockpile stewardship responsibility. For example, the Engineering Science and Applications Division has over 100 engineers involved in some type of weapons-related engineering dynamics project that include such critical skills areas as engineering design and evaluation, environmental testing, and high-performance computing and simulation. We believe this program will also make the students aware of these career possibilities at DOE Defense Programs (DP) laboratories after they have completed their graduate studies. To this end, all students that participated in the 2000 and 2001 summer schools plan to attend graduate school, and they all expressed interest in returning to the Laboratory. Five of the 2000 students have returned to the Laboratory as GRAs during the summer of 2001. The Weapons Response Group is actively recruiting two students from the 2000 class for a staff positions.

## Highlights of This Year's Accomplishments

The program has achieved its primary goals of introducing a talented group of engineering students to both analytical and experimental engineering structural dynamics and of making them aware of career opportunities at DOE DP laboratories. Of particular note, this last goal was further addressed when five students from the first summer school returned to the Laboratory this past summer. Also, the Laboratory has offered full-time staff member positions to two students from the 2000 class. One will graduate with a M.S. degree in mechanical engineering from Georgia Tech. This student had a 3.97 undergraduate GPA at Rose-Hulman Institute of Technology. For the past two years Rose-Hulman has been ranked by *US News and World Report* as the #1 engineering school in the US without a Ph.D. program.[1] The other student will graduate with an M.S. degree in aerospace engineering from Stanford University after obtaining a BS degree from MIT *US News and World Report* ranks Stanford and Georgia Tech as the 2nd and 5th best engineering graduate schools, respectively.[2] Clearly, the recruiting aspect of the summer school is already paying dividends as both these students have verbally accepted this offer. In addition, a third student from the 2001 summer school who will graduate in the spring of 2002 with an M.S. degree in engineering physics from the University of Wisconsin–Madison has recently requested an interview. These recruiting accomplishments directly address the issues raised in the Chiles Commission Report regarding Recommendation #7, "Establish and Implement Plans on a Priority Basis for Replenishing Essential Technical Work Force Needs in Critical Skills."

The student groups produce quality papers that will be presented at the International Modal Analysis Conference. A culminating highlight of the summer school was the oral presentations that the students made to the staff in the Engineering Science and Applications Division. Managers in this division noted that the student presentations were of the quality that the staff would give for a high-level program review in the nuclear weapons directorate. The students' conference papers, their viewgraphs, and detailed summer school information can be viewed at www.lanl.gov/projects/dss.

A paper about the summer school entitled "The Los Alamos National Laboratory Dynamics Summer School—A Mechanics Motivator" was presented at the Annual American Society of Engineering Educators Conference this past June. This paper won the best paper award in the mechanics section at this conference. Also, managers at Boeing and Caterpillar who saw summer school presentations have both approached Los Alamos about the possibility of sending their new hires to the summer school. This interest further attests to perception by outside organizations that the Laboratory has developed a unique program that fills a void in our engineering education system.

## References

[1] See http://www.usnews.com/usnews/edu/college/rankings/engineering/nophd/topprogs_nophd.htm

[2] See http://www.usnews.com/usnews/edu/beyond/gradrank/eng/gdengt1.htm

# Los Alamos Physics Summer School

## Program Description

The Los Alamos Summer School, a joint program of the University of New Mexico (UNM) and the Los Alamos National Laboratory has just completed its twelfth full year. The School targets upper-level undergraduates students, who will soon be making career choices, and recruits nationally to gain the most diverse possible class. We give the students an intense exposure to basic research by concentrating on many fascinating, diverse areas of physics, both through lectures by distinguished scientists on the latest developments and through mentored term projects. These areas include such diverse disciplines as astro-, weapons, condensed-matter, plasma, bio-, laser, atomic, molecular, and optical physics. We also have the broader goal of teaching certain basic physics skills not commonly emphasized in the university curriculum, of introducing high-performance supercomputing, and of fostering a personal interaction between research scientists and students. A knowledge of the workings of scientific research, of the frontier discoveries, and of the newest computer techniques will greatly aid students, no matter what their ultimate career choice. For the past nine years, the School has been funded by a National Science Foundation (NSF) Research Experience for Undergraduates (REU) site grant to UNM and by the Science Education Programs at the Laboratory through a DOE Defense Programs grant in addition to in-kind support from the Theoretical (T) Division and the UNM Center for Graduate Studies and the Department of Physics and Astronomy. This year witnessed a new funding component of a direct grant from line management within the Nuclear Weapons Program at the Laboratory.

The session divides into two complementary activities involving lectures and a mentored student research project. First, the lectures focus on current "hot topics" in the field of physics, motivated from the speaker's own research projects. The lecturer introduces basic physical concepts from the perspective of ongoing research endeavors. This mode of presentation gives the students an opportunity to participate in new investigations. Second, each student works on a research project for the whole summer term. A mentor from the senior scientific staff of the Laboratory or UNM oversees and guides the student through this endeavor. A variety of projects are available; many center heavily on high-performance supercomputing. The mentors carefully craft each research project to fit the background of the student in order to guarantee the greatest and most effective participation. We have found that this dual track of lectures and research best stimulates in the students an active interest in science and avoids the pitfalls of a program devoted exclusively to one track or the other.

For 2001, we kept the ten-week term begun two years ago at the behest of students and mentors, who felt the extra time lead to more productive

projects. Given the enthusiastic response to this year's projects, we could easily extend another two weeks. The students received three hours of course credit from UNM as Physics 501. This credit has been readily transferred to home institutions and, in many cases, has substituted for a senior research project. We scheduled lectures in the mornings and reserved afternoons for research (Figs. 11, 12, and 13), attempting to strike a balance between these two activities. Classes and computer sessions were held on the campus of UNM at Los Alamos; the UNM computer center has a fast link to the Laboratory network while providing powerful local capabilities. The common class and computer rooms as well as their close proximity within student housing all encouraged a natural cohesiveness within the class. We further fostered this class spirit with tours of Laboratory facilities and of local points of interest and activities. The friendships made during the course of the School form an important, enduring feature of the program as commented upon by almost all students, past and present.

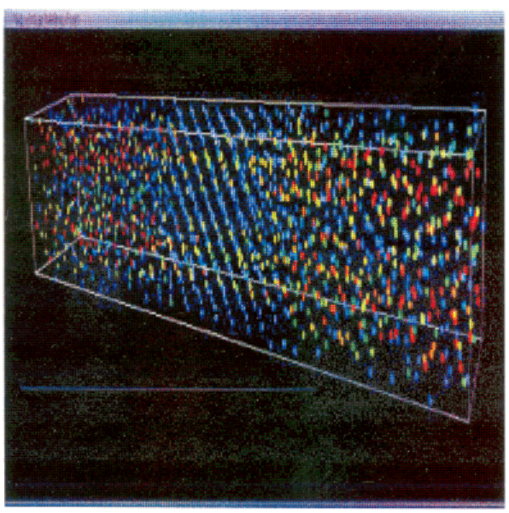


*Figure 11. Molecular dynamics simulation of nickel near melt.*

While this basic formula has served the School admirably over its course, we continue each year to experiment with new educational projects and approaches. These experiments function on a small enough scale so as not to endanger general student performance, yet with a broad enough

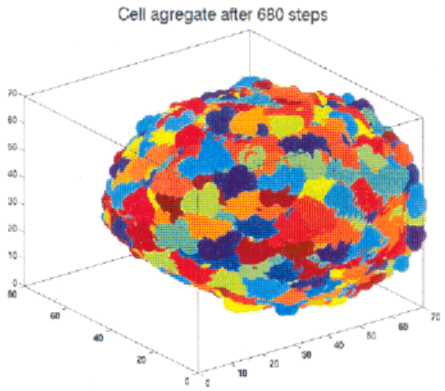



*Figure 12. Avascular tumor.*

scope to provide reasonable extrapolation. This year we developed two special sessions: (1) Physics and Society; and (2) a Conference Experience.

## Performance Objectives and Milestones

The main performance objective centers on the planning and operation of the School to encourage undergraduate students to pursue research careers in the basic sciences, important to the DOE/DP mission. This has become critical as biotech and computer firms now attract the best university students. The short-term milestones of providing exciting projects and lectures to stimulate the students have been amply met. For the intermediate term, we have repeatedly had students return to the Laboratory to continue research activities, students working on advanced degrees with joint Laboratory and university mentors, and students begin tenured-track university positions with continued strong ties with Laboratory personnel. Since the time these undergraduates may take to a doctorate could span seven or eight years, we are just beginning to glimpse the long-term effects of the program.

## Program Highlights 2001

Reflecting the dual nature of the sponsorship, we have co-directors with each taking particular responsibilities for various tasks in operation and organization, based on resources, personnel, and

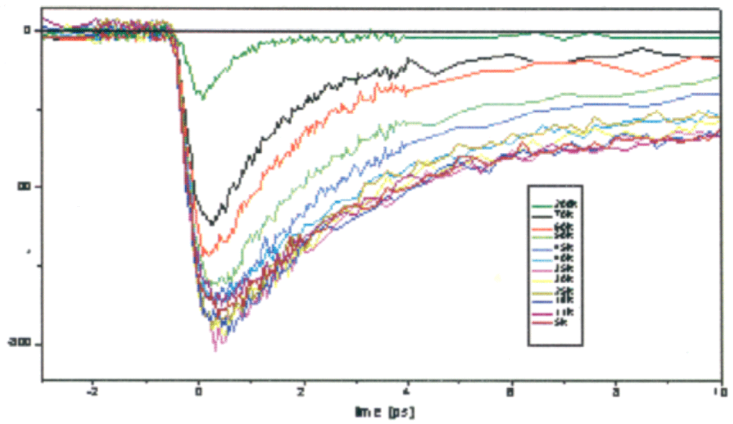


*Figure 13. Pump-probe (1.5 eV) on $YbIn_4Cu$.*

location. For example, UNM has excellent facilities and staff at its several locations to handle the vital task of recruiting and to provide classroom and computer access, while the Lab has the on-site technical staff from which to draw the mentors and lecturers. Professor Sally Seidel serves as co-director for the UNM side, and Dr. Lee Collins for Los Alamos. Prof. Howard Bryant, a co-principal investigator on the NSF grant, provides invaluable service in many areas of the program. The School could not function without the immeasurable contributions of Norm Magee (Laboratory group T-4), Drs. Daniel James (T-4) and Dana Berkeland (P-23), who assisted in the planning and operation of the program.

**Mentored Research Project**

In 2001, twenty students from universities in thirteen states participated in the combined curriculum of lectures and individual research projects. We had our largest participation of mentors to date, beating last year's record, representing seven different Laboratory divisions and seventeen groups as well as UNM. Twenty projects, supervised by twenty-seven mentors, covered such diverse areas as quantum computing, plasma shocks and confinement, neutrino oscillations, ultracold systems, viral infections, fuel cells, materials simulations, and femtosecond spectroscopy and ellipsometry. Topics and principal mentors appear in more detail in Table 8.

All students submitted detailed final reports, crafted along the lines of a standard scientific paper, on their research accomplishments. The papers will be bound into a Laboratory publication (LA-UR-01-4922) for general distribution. To aid in writing these reports, we held a special class on technical writing, given by Dr. Collins, who also serves as an editor to *The Physical Review*. The main emphasis of the School centers on the research *experience*, giving the students a taste of a hands-on technical project. The span of the program remains generally too short for the production of a finished, polished, and publishable piece of scientific research. However, four students already plan to continue work on their projects, either as independent endeavors or as a part of their senior research course at their respective institutions. We anticipate publications in refereed research journals from these continuing efforts. In fact, recent publications from former students of research associated with the School include articles in *Physical Review Letters* [1], the *Journal of Vacuum Science and Technology* [2], and the *Journal of Acquired Immunodeficiency Syndromes* [3].

This year, the Laboratory expanded its annual student poster session into a full scientific meeting, Symposium 2001, that included student talks and posters as well as presentations from universities and corporations. Although the School comprises less than 1% of the student population at the Laboratory, almost 10% of the

## Table 8. Mentors (affiliation) and Research Projects

| Mentor/Affiliation | Research Project Title |
|---|---|
| M. Taccetti (P-24) | |
| **Magnetic Induction Probing Techniques for Magnetized Target Fusion** | |
| F. Cherne (MST-8) | |
| **Examining Properties of Materials with Molecular Dynamics: A Study of Nickel** | |
| M. Holzscheiter (P-23) | |
| **Stability of Pure Electron Plasma in Inhomogeneous Magnetic Fields** | |
| W. Hlavacek (T-10) | |
| **Activation of Complement by HIV and Complement-Mediated Attachment of Virus to Follicular Dendritic Cells** | |
| S. Cohen (LANSCE-6)/ H. Bryant (UNM) | |
| **Searching for $H^-$ Resonances in Stellar Atmospheres** | |
| R. Kanzleiter (X-2) | |
| **Analysis of Near Analytic Solutions to Converging Shock Waves in a Cylindrical Geometry** | |
| D. James/J. Grondalski (T-4) | |
| **Teleportation as a Measure of Entanglement** | |
| M. Murillo (T-15) | |
| **Molecular Dynamics Calculation of Yukawa System Phase Diagram** | |
| G. Bender/ A. Saab (MST-11) | |
| **Automation of Membrane Electrode Assembly Production for Polymer Electrolyte Fuel Cells** | |
| A. Hime (P-23) / M. Dragosky (C-INC) | |
| **Data Analysis of the Ratio of Background to Signal from $^{252}Cf$ Calibration Source for Sudbury Neutrino Observatory** | |
| E. Ben-Naim (T-13)/ R. Ecke (MST-10)/ Z. Daya (T-CNLS) | |
| **Topological Constraints in Vertically Vibrated Granular Chains** | |
| E. Liong (P-21) | |
| **High-Throughput Isolation of Biological Macromolecules** | |
| Hui. Li (X-1) | |
| **Magnetorotational Instability of Liquid Sodium Couette Flow** | |
| Yi Jiang (T-7) | |
| **Cellular Model for Avascular Tumor Growth** | |

Symposium 2001 participants came from our program. Our students gave two talks and nine poster presentations. One student, Jonathan Schauer, was awarded the Best Undergraduate Poster prize—quite an accomplishment for a small group over such a short period.

Several of our past students returned to the Laboratory to work with various research groups, based on contacts and projects initiated with the School. One of the students, Anne Arroyo (LASS00), completed a master's degree in physics with Dr. Dana Berkeland (P-23) and her research Professor at California State at Fullerton, Heidi Fearn. Another student, Daisy Raymondson (LASS99), plans to work toward an advanced degree with Dana and her advisor at UC Davis.

### Lectures

In addition, the students attended a full set of lectures on an extensive range of topics as outlined in greater detail in Table 8. These lectures serve as a perfect vehicle to highlight the

expansive, high-quality research programs of both institutions and provide a marvelous recruiting opportunity. Distinguished lecturers were drawn from outside universities and research organizations, from the University of New Mexico, and from the Laboratory [6 divisions and 18 groups!]. The almost immediate filling of all lecture slots upon announcement of the program attests to the popularity of the School amongst a broad range of scientists at the Laboratory. The talks give staff a rare opportunity to address in an informal setting a group of highly talented students. The outside participation was our largest yet including Prof. N. Lane (Rice), Prof. E. Weigold (Australian National University), Prof. J. Eberly (Rochester), Profs. P. Gould and J. Javanainen (Connecticut), and Prof. H. Fearn (Cal State). We continued our strong participation from UNM, which highlights the important ties between the University and Laboratory generated by this program. We again drew upon the enthusiastic participation of the junior scientific staff at Los Alamos, mainly from postdoctoral fellows.

This opportunity often provides their only experience in preparing and giving lectures to a student group.

We continued our broader program on Physics and Society. In addition to our regular introductory lectures concerning the place and responsibilities of science in the world and culture, we had a very special segment given by Prof. Neal Lane, past Presidential Science Advisor. This involved an informal talk exclusively to the Summer School class, allowing ample time for questions and interactions. The talk proved the most popular single event of the School. Several of the students have already begun to correspond with Prof. Lane on the stimulating, thought-provoking points of his presentation. Additional projects through the term built upon these links to cultural ideas, for example, through a talk and class trip to a performance of the Santa Fe Opera.

The lecture series has been open to all other Laboratory educational projects, and we have routinely distributed the schedule to the undergraduate (UGS) and graduate (GRA) programs. Many of the lectures were attended by students from other programs.

**Activities**

In addition to the formal lecture and mentor programs, we have arranged for a wide variety of related activities for the students. We had tours of various Laboratory facilities including the Neutron Scattering Center (LANCE), quantum computing laboratories, and the pulsed-power Atlas facility. Our traditional Night at the Santa Fe Opera (SFO) continued by attending *Mitridates*. We have over the years fostered a special relation with the SFO and have been able to acquire block tickets so that the whole class can conveniently attend a single performance. This event reflects a trend in recent classes, especially given our recruitment from liberal arts colleges, of dual majors in the sciences and the arts.

As a special activity, the students attended the International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC) held in Santa Fe in July. We concentrated this conference experience into a single day that included plenary, invited, and poster sessions as well as the reception. Most of the class had not attended a major scientific conference so this gave an intense overview of the many activities and operations of such a professional gathering. The poster session proved particularly popular since the class got many ideas for their own presentations later at Symposium 2001. For this coordinated endeavor, we drew upon our past success in the Conference Experience for Undergraduates program [4], also funded by EPO and NSF. The International Organizing Committee, and especially the local group, headed by Dr. Jim Cohen (T-4 group leader), provided invaluable and enthusiastic assistance.

## Recruitment and Demographics

Unlike most REU sites, we recruited nationwide with an emphasis on students from schools with little or no graduate research programs. The University of New Mexico handled the recruitment phase, consisting of an extensive mailing of fliers to all members of several American Physical Society Divisions (about 2000). In addition, a color poster was sent to most physics, chemistry, and astronomy departments in the United States. Special mailings went to minority-designated institutions. We have worked closely with other efforts within the science education area at the Laboratory, including the Historically Black Colleges and Universities program. We have also developed a Website [http://www.phys.unm.edu/LASS] that gives general information and allows direct applications. For 2001, we received over 115 applications, up slightly from last year, and admitted twenty students (Figs. 14 and 15).

This class was very strong scholastically, filled with many honors students. The students came from nineteen different universities from Massachusetts to California. These included liberal arts colleges with small research programs to large research-oriented schools. Our participation by women held this year at 20%, still down from several years ago. This reflects a trend noted at other REU sites and appears related to a greater degree to competition among programs rather than a drop in participation or graduates. Other underrepresented groups included Native-American (1), Afro-Americans (1), and Asian (1) participants.

**Schools**
Luther College (IA)
Allegheny College (PA)
Bard College (NY)
Fort Hays State University (KS)
University of Nevada-Reno (NV)
University of Minnesota-Morris (MN)

*Figure 14. Summer school participants.*

University of Rochester (NY)
University of South Alabama (AL)
Berea College (KY)
University of California-Riverside (CA)
Cornell University (NY)
Ramapo University (NJ)
Concordia College (MN)
Harvard University (MA)
University of Massachusetts (MA)
Hendrix College (AR)
Arizona State University (AZ)
Drake University (IA)
Drexel (PA)

*Figure 15. Student participants.*

## Evaluation

Evaluation of such a project has always been difficult. We performed an impact evaluation, asking the students the immediate importance of their participation in the School. The consensus this year followed remarkably closely that of previous years. The following general findings about the course emerged: (1) well organized and at about the right level, (2) helped improve understanding of basic concepts in the field, (3) required a reasonable amount of work, (4) provided skills applicable to their careers, (5) gave appreciation of high-level computer power, and (6) fostered an informality that nurtured interactions with renowned scientists. We were gratified with the response from most of the students that the School had " renewed their interest in science and computation." Therefore, the short-run effects of the School were clearly very positive.

This year, Prof. Bryant made a concerted effort to contact students from the previous few classes; those for which we still had fresh tracks in cyberspace. About 30% of these students responded. All indicated that they have continued in the physical sciences and plan to seek advanced degrees. An interesting and encouraging trend emerged regarding liberal arts students, which we have diligently recruited. All that responded have been accepted into top-flight graduate schools in science, including the University of California, Cornell, Johns Hopkins, the University of Chicago, and Yale, to list but a few. The students continue with their praise for the program and their regard for the Laboratory's research programs.

In a departure from the usual staid nature of such reports, we include in an Appendix an important gauge of success of any program: anecdotal information from some of our students taken from this recent survey.

## Budget

The FY00 budget ran at $195,000 with $70,000 from the NSF-REU grant and $100,000 from Nuclear Weapons line management, and $25K from Science Education programs. In addition, considerable in-kind support (~$70,000) comes from both institutions including materials, computer time, and staff. In addition, T Division provided a $10K special grant. The students were paid a stipend of $4500 for the session that covers UNM tuition, travel, and subsistence. Housing costs, always a major expense in Los Alamos County, were borne directly by the School. The difficulty in obtaining housing during the summer and the expense was greatly reduced by having new UNM housing available to the School. In addition to being enrolled as nondegree students at UNM, students are placed on assignment at LANL so as to utilize the many facilities such as the Library as well as to provide easy access to the mentors.

## DOE/DP Mission Benefit

The School began as an internally-funded project within the Los Alamos Weapons Program to encourage greater participation by outstanding students in research areas deemed vital to many DP missions. With the funding and policy changes of 2001, we have, in some respects, returned more strongly to this initial purpose.

The basic goals of the Los Alamos Summer School closely align with recommendations of the Chiles Report, especially item 7, to "replenish the essential work force needs" of the weapons laboratories. Specifically, the program gives high profile and presence through its national recruitment process that targets both students and teachers at over 2000 universities and colleges, its use of distinguished lecturers from outside academic institutions, and its alumni.

The School serves as a ten-week intern program in which students become actively involved in a variety of research programs around the Laboratory. In addition, our classes have had strong participation by women, consistently at a percentage well above of that in university physics programs at the same level. We have also employed many women scientists as mentors and lecturers to serve as role models.

Programs like the Summer School, which concentrate on undergraduate students, provide a unique and powerful vehicle for captivating and recruiting highly-talented students with tremendous career potentials into areas of critical interest to the national security in general and to DOE in particular. As indicated by our evaluations, the Los Alamos Summer School fosters in students an extremely positive view of the Laboratory and its multifaceted research programs. We must build on this enthusiasm with a coordinated series of interlocking programs that follow and attract students all along the lengthy path to a professional degree.

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[1] D. Morr, T. Trautman (LASS), and M. Graf, Phys. Rev. Lett. **86**. 5978 (2001).
[2] D. Hanson, B. Stephens (LASS), C. Saravanam, and J. Kress, J. Vac. Sci. Technol. **19**, 820 (2001).
[3] D. Roberts (LASS) and M. Ribeiro, JAIDS **27**, 331 (2001).
[4] L. Collins, N. Magee, H. Bryant, and. M. Zeilik, Am. J. Phys. **67**, 685 (1999).

### Student Comments

*"Hello - I hope no one minds a reply to the group! I at least am interested in what the other alumni are up to, and hopefully this mass response doesn't offend anyone. I'm preparing to start my second year in grad school at UC Berkeley. I've been working this summer (and last) on the CDF experiment (one of the two colliding beam experiments there) at Fermilab....So, I'm not doing anything too directly related to my time at LASS. But, I would like to (re-) affirm that it was a wonderful program and an enriching summer. The morning lectures were especially useful giving me a much broader perspective on current research (especially in atomic and optical systems, and condensed matter) than I could have otherwise gotten. I'd also like to affirm the diversity of lectures that were offered [i.e., not just atomic, molecular, and optical (AMO) physics]. Especially Sally Seidel's overview of the Standard Model - being the most directly related to what I'll be up to these next few years! I hope everyone's well, and would love to hear from the rest."*
*Adam—July 30, 2001, Class of 1999, UC Berkeley/LBL*

*"Hello, I am currently doing an REU at Cornell's CESR. I graduate in spring 2002 from Florida State and am doing an honors thesis on Monte Carlo simulations of phase change dynamics using an Ising lattice-gas model. I hope to pursue graduate studies in physics. I am strongly considering quantum information for a*

*PhD thesis topic and have been trying to pursue this field since the lectures I attended at LASS last summer. I hope this helps LASS continue to motivate and educate eager physics majors." Thank you,*
*Daniel—July 30, 2001, Class of 2000*

*"Hello, I'd be glad to give you some info. I thought LASS was great and I'd like to see it continue. I graduated in May 2001 from Wayne State with a B.S. in Physics and a B.S. in Mathematics. I'm beginning grad school (for physics) in September at UC Santa Barbara. I'm not sure yet what I plan to study, but I'm sure it will be theory of some sort. If you want more, don't hesitate to ask." Regards,*
*Eric—July 30, 2001,Class of 2000*

*"Dear Howard, After LASS 2000 last summer I went to graduate school at the University of Glasgow in Scotland. This summer I have returned to Los Alamos to work again with the mentor I had with LASS. The research I am doing this summer is a continuation of my LASS project last summer. This work will be included as part of my PhD thesis in Glasgow. I will most likely return to Los Alamos as a GRA within the next year. Hope this helps. Best wishes, Rejean"—July 30, 2001, Class of 2000*

*"hey guys...i plan to go back into academics when my stint with the military is up, probably getting my phd in particle/high energy theory (or perhaps condensed matter theory). i worked with dirk morr last summer on superconductivity. our paper just recently got accepted by physical review letters, if he did not tell you, i was very excited about that one. LASS was my third summer science thing, this was the first paper i got out of it. plus the class was incredible and the people were unusually cool too."*

*".... you have the only unique/really ingenious reu type program on the market.*
*pete"—July 30, 2001, Class of 2000*

*"Hello Dr. Bryant, My Name is Arlene * and I attended LASS 2000. I will go to Texas A & M University in the Fall in their PhD Physics Program. High Energy Physics/Nuclear Physics are my interests at this time."*
*Arlene—August 1, 2001, Class of 2000*

*"Hello everybody. I will be starting my third year of physics grad school this fall at the Univ of Chicago (I'm feeling old here). I'm working with Sean Carroll on cosmology and particle physics—specifically, I'm trying to figure out if quintessence can explain both the time variation of the fine structure constant and the accelerating universe. I really enjoyed my summer in Los Alamos, in fact, that was my most productive/ fruitful summer by far as an undergrad. I learned some physics, I learned that there was more physics than I could ever possibly know, and I learned to swing dance (or I tried). Thank you LASS for that unique opportunity. Take care,"Jennie—August 3, 2001, Class of 1999*

# Materials Technology Training Pilot Program

## Program Description

Materials science technicians play an important role in the ability of Los Alamos National Laboratory to fulfill its mission to continue to ensure the safety and reliability of the US nuclear weapons stockpile; to reduce threats to US security; to use science to clean up the legacy of the Cold War; and to provide technical solutions to key energy, environment, infrastructure, and health security problems. The Materials Science Technician Training Program was established to replenish one category of essential technical personnel, materials science technicians, in anticipation of recognized future needs. "Nuclear and Advanced Materials" is recognized as a Laboratory Core Competency, and materials science is a Critical Skills area. The groundbreaking is slated for the summer of 2002 for the new Center for Integrated Nanotechnologies (CINT), one of five centers being established by the Department of Energy, Office of Basic Energy Sciences (DOE/OBES) to form an integrated national program of Nanoscale Science Research Centers (NSRCs) affiliated with major facilities at the DOE's national laboratories. These centers will cover the diverse aspects of nanosciences and will leverage existing DOE facilities. This complex aspires to become a cornerstone of the nation's nanotechnology revolution, contributing to DOE's principal missions in national defense, energy, and the environment while providing an invaluable resource for universities and industries.

Materials science technicians to support these efforts must be recruited, and will be recruited from the region; traditionally, this has always been so. This training program, which offers full-time work at a living wage with benefits, targets a hitherto-untapped pool of working adults who possess valuable skills but who do not wish to, or cannot afford to, attend college on a part-time basis or earn the wages of a student intern. In addition, the education and training included in this program improves retention rates, productivity, efficiency, and flexibility and improves morale of technician trainees. The scientist/supervisor benefits from a technician who can contribute quickly, and who is engaged in a specialized materials science education, and is not being paid from research funding.

Table 9 shows that materials science technicians are employed in several divisions at the Laboratory. It also shows that there were no technicians, Level 3 (TEC 3) employed at the Laboratory prior to the six participants recently hired in this program. In addition, there are few technicians Level 4 or 5 currently employed at the Laboratory. This dearth of entry-level technicians has

**Table 9. Materials Science Technician Statistics—LANL—2001**

| Division | TEC 4 | TEC 5 | TEC 6 | TEC 7 | Total |
|---|---|---|---|---|---|
| C | | | 1 | | 1 |
| DX | | | | 1 | 1 |
| EES | | | 1 | 1 | 2 |
| ESA | | 3 | 3 | | 6 |
| MST | 1 | 5 | 35 | 18 | 59 |
| NMT | 2 | 10 | 27 | 7 | 46 |
| | 3 | 18 | 67 | 27 | 115 |

serious ramifications regarding career succession planning, the aging work force, knowledge and critical skills transfer, and recruitment and retention issues.

Table 10 lists ages of technicians at the Laboratory. An aging work force is clearly demonstrated by the fact that 73.9 % of materials science technicians and 76.1 % of all technicians regardless of specialty are aged 40 and older.

The main focus of the Materials Science Technician Training Program centers on recognizing future work force needs, proactive planning and implementation of the plan to address perceived shortages, and subsequently ensuring that the Materials Science and Technology Division has the highly-skilled and motivated employees it needs to fulfill the division's and the Laboratory's mission.

It is recognized that students in the region are not exposed to materials science in their elementary or secondary school coursework. Post-secondary education in materials science is needed to produce the specialized technical workers needed at the Laboratory, since currently no such formal training mechanisms or programs exist in northern New Mexico to serve as a pipeline to direct talented and trained individuals toward a career in materials science at the Laboratory. Technicians educated in materials science fundamentals can more easily, quickly, and efficiently reposition themselves in new areas of research. Successful training program applicants will be high school graduates or possess a general equivalency diploma (GED). The certificate-degree granting program at the Los Alamos branch campus of the University of New Mexico encompasses two years of part-time (9 credit hours per semester) enrollment.

The ultimate goal of this program is to establish and implement at the Laboratory a long-term, strategic, institutionalized Technician Training Program (for all TEC series) on a priority basis for replenishing essential personnel. This training program must address work force development, aging work force, 'pipeline' issues, career succession, maintenance of critical skills, and transfer of knowledge.

## Program Description/Design

The Materials Science Technician Training Program includes a certificate-degree-granting program at the University of New Mexico – Los Alamos Branch Campus in addition to employment as a limited-term Materials Technician, Level 3 at Los Alamos National Laboratory. Participants will be employed for two years in the Los Alamos National Laboratory's Materials Science and Technology Division. Technician trainees are assigned to work under the guidance

**Table 10. 2001 Technician Ages**

| Age | MS TEC | All TEC |
|---|---|---|
| 16-24 | | 9 |
| 25-29 | 3 | 60 |
| 30-34 | 7 | 100 |
| 35-39 | 20 | 209 |
| 40-44 | 15 | 311 |
| 45-49 | 31 | 364 |
| 50-54 | 25 | 299 |
| 55-59 | 13 | 182 |
| 60+ | 1 | 49 |
| | | 115 1583 |
| | | 73.9% 76.1% 40 and older |
| | | 33.9% 33.5% 50 and older |

of, and be mentored by, technical staff members and senior materials science technicians and will be assigned to research projects investigating challenging and important technical problems in critical skill areas directly benefiting the DOE/DP mission. It is envisioned that ten technician trainees will be hired every year.

A portion of the technician trainee's workday will be spent at the university attending academic courses specially designed for and directly relating to their job at the Laboratory. The coursework helps program participants develop critical skills that enhance the short-term and long-term productivity and viability of the Laboratory. At this time, there is no formal training in northern New Mexico for materials science technicians; this program addresses this perceived need. The availability of trained, professional technicians is a powerful recruiting tool to attract research scientists to the laboratory. On-the-job training of trainees at an entry-level technician grade (TEC 03) is efficient and low-cost to the Laboratory and provides an excellent dollar return on the investment.

The curriculum includes an introductory course in metals, polymers, and ceramics; an "elements of chemistry" course; and other courses as determined by an advisory council. The inclusion of experienced materials science technicians on the advisory council will ensure that coursework complements and enhances the work experience at the Laboratory. Potential hires will be screened to determine technical aptitude and academic preparedness for the curriculum prior to admittance to the program in order to minimize the possibility of failure. Students will be matched with Laboratory research scientists working on exciting projects. Developing a student-training program in materials technology will require a team effort using the knowledge and expertise of University of New Mexico staff and instructors as well as Laboratory materials scientists and materials science technicians.

Upon successful completion of the two-year training program, students will be awarded a Certificate in Materials Technology from the University of New Mexico. At that time, continued employment at the Laboratory is a possibility, dependent upon position availability and funding. Students will also have the opportunity to continue their education at the University of New Mexico by earning an associate's or bachelor's degree. Students would also have the option of pursuing a bachelor of science degree in materials science and engineering at the New Mexico Institute of Mining and Technology in Soccoro. Each mentor-supervisor will develop a work plan for each student intern. Student interns will be evaluated both in their courses at UNM-LA and in their work by their Laboratory supervisors.

Table 11 shows that over half of Laboratory technicians have no post-secondary school education.

The program participant recruiting strategy includes

- Creating and disseminating a brochure describing the program
- Certificate Degree Program description and curriculum and course listing in the University of New Mexico-Los Alamos branch course catalog
- Descriptive articles in Laboratory publications
- Speaking engagements at local public secondary schools
- Job ad posting at the Laboratory's website

**Table 11. All TEC Series: Regular Employees by Highest Degree for TEC Series**

| None | APP | Assoc | BA/BS | MA/MS | DVM | PhD | Total |
|---|---|---|---|---|---|---|---|
| 841 | 116 | 325 | 245 | 57 | 1 | 7 | 1592 |

## Performance Objective and Milestones

Performance Objective for 2001: Implement the program and hire participants.
Milestone reached: Participants applied for a job, were matched to a supervisor, and hired.
Milestone reached: Courses were developed, and the Certificate-Degree Program curriculum was developed and approved by the University.
Milestone reached: Six students on schedule to graduate with a Certificate in Materials Science Technology from UNM-LA in June 2003.

Performance Objective for 2002: Institutionalize program at a level higher than division level, so scientists and materials science technicians in the Nuclear Materials Technology (NMT) and ESA Divisions can participate in the program.
Milestone to be achieved: Fund program for ten hires/year at a level higher than division level.
Milestone to be achieved: Hire at least one participant/technician trainee in the Nuclear Materials Technology (NMT) Division.

These performance objectives contribute to the Laboratory's mission to ensure the safety and reliability of the US nuclear weapons stockpile; to reduce threats to US security; to use science to clean up the legacy of the Cold War; and to provide technical solutions to key energy, environment, infrastructure, and health security problems by creating a means to recruit, hire, and retain a highly trained and highly educated work force. These trained materials science technicians directly contribute to ensuring that the Laboratory has a work force that is competently trained in DOE-DP Critical Skills area #4: Materials Science and Technology, which includes

- Specific materials expertise (e.g., Pu, Be)
- High explosives properties study and fundamental modeling
- Compatibility
- Computational materials modeling
- Mechanics of materials
- Materials science measurements
- Surface science
- Organic chemistry
- Metallurgy
- Radiochemistry

## Highlights of This Year's Accomplishments

After receiving funding from DOE-DP to create a Materials Science Technician Training Program in late 2000, the Laboratory's Materials Science and Technology Division Director fully funded the Project Director to create and implement a two-year training program that incorporated a Certificate Degree-granting curriculum at the University of New Mexico – Los Alamos branch and an internship with a supervisor/mentor at the Laboratory. The first order of business was threefold: develop courses at UNM-LA, recruit participants, and recruit Laboratory scientists to be supervisors.

Working with UNM-LA staff, the Certificate Degree Program was developed. All courses except the MST courses were already available on campus. A two-year curriculum was designed to incorporate courses such as chemistry, algebra, and trigonometry, which would provide a foundation for understanding materials science and technology concepts. The two "Introduction to Materials Science" courses set the stage for the four specialty materials science courses, which provide a deeper comprehension of the structure-properties-processing-performance relationships that materials exhibit. The "Materials and Process Selection" course provides an opportunity for Laboratory scientists to task their student-technicians with designing a process or part that is needed in the workplace.

## UNM-LA Materials Science Technology Certificate Suggested Cycle

| Course Number | Course Name | Credits |
|---|---|---|
| **Fall Semester (1st)** | | |
| Engl 101 | -Composition I: Exposition | (3) |
| MST 101T | -Introduction to Materials Science Technology I | (3) |
| Math 119 | -Algebra | (4) |
| **Spring Semester (1st)** | | |
| Math 123 | -Trigonometry | (2) |
| MST 102T | -Introduction to Materials Science Technology II | (3) |
| Chem 111L | -Elements of General Chemistry | (4) |
| **Fall Semester (2nd)** | | |
| CT 102LT | -Introduction to Microcomputers on the PC | (4) |
| MST 104T | -Introduction to Microscopy and Microstructures | (3) |
| MST 106T | -Principles of Heat Treating | (3) |
| **Spring Semester (2nd)** | | |
| Engl 119T | -Technical Communications | (3) |
| MST 108T | -Introduction to Mechanical Behavior of Materials | (3) |
| MST 110T | -Materials and Process Selection | (3) |
| **Summer** | | |
| MST 296T | -Materials Science Technology Cooperative Work Phase 1, 2, or 3 | (1–3) |

## UNM-Los Alamos MST Course Descriptions

### MST 101T-Introduction to Materials Science Technology I (3)

The course will introduce students to fundamental concepts in materials science and technology. Topics to be covered include atomic bonding, microscopic structure, mechanical deformation, phase diagrams, and processing of metals, ceramics, polymers, and composite materials.

### MST 102T-Introduction to Materials Science Technology II (3)

The course will build upon the fundamental concepts in materials science and engineering, as applied to engineering disciplines, and as introduced in Introduction to Materials Science I. Students will learn about the structure of ceramics, polymers, and composite materials and how corrosion resistance and thermal, electrical, magnetic, and optical properties and derived from structure. Students will also learn about materials selection and design considerations, and the economic, environmental, and societal issues in material science and engineering. (Prereq: MST 101T)

### MST 104T-Introduction to Microscopy and Microstructures (3)

Metallography is the study of the interrelationship between the structural characteristics and the physical and mechanical properties of metals, alloys and nonmetallic materials such as ceramics, polymers, and composites. Structural interpretation of these materials is made possible by viewing specimens with microscopes, both electron and light. Students will learn to recognize features in the microstructure that give information about processing, mechanical properties and defects, and how to correlate microstructures to manufacturing and heat treat processes. Students will gain some understanding of which features are the true microstructure and which are preparation artifacts.

### MST 106T-Principles of Heat Treating (3)

This introductory course will address the purpose of, and various types of heat treatment. The types of furnaces, and the quenching media used in heat treating will also be discussed. The heat treating of steel, aluminum alloys and titanium alloys will be discussed in detail. (Prereq: Math 119 and Chem 111L)

### MST 108T-Introduction to Mechanical Behavior of Materials (3)

This course is designed to introduce the student to the basic mechanical behavior of metals, ceramics, and polymers. The origin of mechanical properties in engineering materials is discussed from a fundamental viewpoint and the concepts are used to explain how various methods used to strengthen materials actually work. Properties such as tensile strength, ductility, elastic modulus, hardness, fatigue life, and toughness are covered in this seminar. (Prereq: Math 123)

### MST 110T-Materials & Process Selection (3)

Students will use the knowledge gained in previous materials science courses to solve a materials-related design problem. Students will be asked to search the literature, select materials and processes needed to design a part, a machine, or a process, and present oral and written reports.

Course content and lecture materials for MST 101T and MST 102T are based on those developed for the MSE 205 course offered at The Ohio State University's Materials Science and Engineering (MSE) Department. Lectures are based on an interactive PowerPoint slide show. Students are provided with color copies of all slides prior to the class lecture; thus, students are able to interact more easily and completely with the lecturer because the need to take notes is not overwhelming. Ten copies of the textbook *Materials Science and Engineering An Introduction*, fifth edition, by William D. Callister, Jr. and the CD-ROM *IMSE: Interactive Materials Science and Engineering*, third edition were donated by the publisher, John Wiley and Sons, Inc. Each student was given a copy of the CD-ROM. Animations and 3-D projections allowed the students to visualize processes and concepts that are sometimes difficult to understand.

Two of the advanced materials courses will be developed as on-line courses. Currently, a proposal has been made to the NSF for funds to achieve this goal. Notification of success or failure should occur within the next few months. Following is a project summary of the proposal. If funding is not awarded, the courses will be taught using ASM International videos and self-study materials.

## Materials Science and Technology Online

### Project Summary

To meet the materials science training and curriculum requirements of community college students and instructors, we propose to develop a model for a certificate and Associate of Technical Arts degree (ATA) program in Materials Science and Technology (MST) that takes advantage of online course delivery to reach students nationwide. The model will be developed and tested at Edmonds Community College (EdCC) and the University of New Mexico–Los Alamos Branch (UNM-LA). Through a workshop held at the end of the project, invited community colleges will be encouraged to offer online materials science and technology courses to establish a national distributed certificate and degree program.

**To achieve the goals of this project, efforts will be focused in three main areas:**

- Survey industry and educational institutions to determine the course requirements for a Materials Science and Technology Certificate and ATA degree
- Develop, test, and evaluate two online materials science and technology courses to determine the feasibility and practicality of

distance learning for technology students
- Obtain potential academic partners to establish a national network of materials science and technology online courses.

ASM International will provide assistance in establishing the course requirements and in course development. ASM International, a professional materials society, currently offers through their Materials Engineering Institute over 75 materials science and technology training courses available in face-to-face seminar, self-study, and videotape formats. Edmonds Community College has one of the largest distance learning programs in Washington state and has consistently been a leader in the implementation of distance-delivered courses. By combining ASM International's expertise in materials science and technology curriculum with Edmonds Community College's expertise in online course delivery, community colleges and industry would greatly benefit. University of New Mexico–Los Alamos Branch expertise gained from developing their Materials Science Technology Certificate program will be used as the basis for the online certificate and degree programs.

The online courses will also provide materials science and technology training to current and new technicians in industry and professionals who need to be updated on changes in advanced materials science and technology. The online courses can also be used in various state job training and certification programs. The feasibility and practicality of distance learning for community college students in engineering and technology will be established. Issues such as hands-on activities for online technical courses will be addressed, and alternatives to on-site laboratory classes will be investigated.

Nine students were recruited and enrolled in the Introduction to Materials Science course in August, 2001. Six students successfully completed the course in December 2001. During the summer of 2001, information about the technician training program was disseminated both formally at student orientations at UNM and in Laboratory news publications, and informally through personal e-mailings and word of mouth. Recruitment of scientist supervisor/mentors was accomplished through MST Division mailings and personal phone calls. The project director has eight years experience working as a materials science researcher in the division, and thus has many personal and professional contacts.

Los Alamos National Laboratory Job Ad 028088 was posted to formally hire ten limited-term Materials Science Technicians, Level 3, at a salary of $30,000 per year. The job ad was open for ten days and resulted in 96 applicants, of whom 22 have been interviewed. At this time, the six program participants enrolled in the UNM-LA Certificate Program have been matched with a supervisor in the MST Division, hired, and have started work in their respective laboratories.

**Examples of the type of research work that the technicians will be involved with:**
- basic research in an ultrafast-laser laboratory on a number of unique materials, particularly those with novel superconducting, magnetic, and dielectric behavior
- materials synthesis and characterization basic research in the Magnetic Resonance Force Microscopy Laboratory, where a new scanning probe technique based on mechanical detection of magnetic resonance is being developed
- development of fuel cell components, stacks and systems
- basic research into thermoacoustic phenomena
- work with the welding, metallography, metal fabrication, and powder metallurgy teams on various research projects in the Metallurgy Group

# Modern *f*-Element Chemistry

## Program Description

This project continues the unique undergraduate/graduate-level course, which is focused exclusively on the molecular chemistry of the actinide elements. The program, which is fully accredited by the University of New Mexico (UNM), features both a lecture course and selective research fellowships, and is coordinated through the Seaborg Institute for Transactinium Science (ITS). The lecture course is usually presented during the summer semester at UNM-Los Alamos (UNM-LA). The lectures provide an introduction to the chemistry of the actinide elements—an area that is frequently overlooked in most undergraduate and graduate courses. The 12-week summer research fellowships entailed participation in both the lecture course and independent research projects.

## Performance Objectives and Milestones

Our aim is to continue development of an internationally recognized educational program which will (1) act as a national resource for the teaching of nuclear sciences, (2) provide a vehicle for early recruitment of the next generation of nuclear scientists and engineers, (3) offer accredited courses which can expedite a student's graduation, and (4) provide a mechanism for the career development of the Laboratory's, DOE's and National Nuclear Security Administration's staff and technicians. Due to the success from the previous years, this program was continued and grew to include new areas, e.g., general weapon technologies and dynamic experimentation. We are hopeful that this growth will continue in subsequent years, and will lead to establishment of a number of similar educational curricula in related disciplines, e.g., materials, metallurgy, and interfacial and environmental aspects of actinide science. At the conclusion of the course the students acquired a greater appreciation of the diverse role of actinide chemistry in nuclear energy and national security. With this insight, together with the introduction to the extensive research facilities available at National Laboratories, we were able to stimulate talented young researchers toward careers in actinide, nuclear, and weapons science. All previous milestones listed in our proposals, including Fellows search, presenting the course, and research presentations and publications were realized, and we are continuing this trend in the current fiscal year. In addition, we are continuing to expand and adapt the program to access larger groups of students, staff, and technicians.

## Highlights of This Year's Accomplishments

We detail below our progress for the 2001 fiscal year on four separate projects: (1) the Summer lecture course at the Laboratory; (2) sponsoring of research fellows in actinide and weapons science during the summer of 2001; (3) a satellite broadcast short course, seminar and workshop series on critical skill areas; and (4) extension of the educational program to new areas of the Defense Programs mission. In support of nuclear science educational efforts, the Laboratory has established and funded this fiscal year a new position within the Seaborg Institute, Associate Director for Education. Dr. D. Webster Keogh has subsequently accepted the position. Overall, the program had 17 direct participants, including staff, technicians, and students (undergraduate and graduate) and another seven indirect participants consisting of four graduate students and three professors. These indirect contacts have resulted in an unforeseen benefit to the program. A number of fruitful collaborations

between university faculty and laboratory staff have been initiated, and further sharing of students and resources is growing.

(1) Arrangements were made to present the "Modern *f*-element Chemistry" course at the University of New Mexico's Los Alamos campus, and the course was added to the summer schedule [as course numbers CHEM 325 (undergraduate) and CHEM 537 (graduate)]. The collaboration with the broadcasting personnel at the Waste-management Education and Research Consortium (WERC) site at New Mexico State University was continued, where a rebroadcast of the signal via satellite was sent to downlink sites around the country. The class was taught from June 4th to July 27th, and we had an enrollment of 13 students, ranging from undergraduate and graduate students to technicians and technical staff.

(2) In December 2000, we distributed posters to approximately 125 chemistry departments nationwide announcing our intention to fund six Seaborg Institute Research Fellows during the summer of 2001. We also have updated and maintained our Website (http://pearl1.lanl.gov/seaborg) to provide information about the Seaborg Institute and its educational programs as well as to allow fellowship applicants to apply online. The deadline for applications was March 1st. The selected candidates were composed of two senior undergraduates (from San Jose State University and Colorado State University), and two graduate students (from the University of Texas, Austin). The majority of the Fellows were at the Laboratory for 10–12 weeks, starting in June 2001. Two of the Fellows extended their stay until October, and another two will be returning on a regular basis to perform research at the Laboratory. They attended the "Modern *f*-Element Chemistry" course in addition to performing independent research under the guidance of Laboratory scientists. During their summer research, they gave oral presentations of their work to groups of staff, postdocs and fellow students. Tours and demonstrations were also organized this year of TA-55, the plutonium processing facility, and a destruct shot (500-pound explosive test).

(3) In March 2001, we purchased satellite time for the months of June and July 2001. This purchase will provide our programs access to the same satellite 24 hours a day seven days a week during the prescribed months. This access will enhance our ability to reach other universities, DOE, and NNSA sites by simplifying the receipt of our broadcasts to a single satellite position. Within these complexes, a variety of people exist with differing educational backgrounds and needs as well as time constraints. In order to accommodate these people, we tested the use of this satellite as a potential mechanism to sponsor future short courses, workshops, and seminar series in nuclear and weapons-related sciences. The different educational approaches are designed to target the various audiences, maximizing information exchange while minimizing time requirements.

(4) In an attempt to broaden our program to include general weapons-related science we have begun to interact with other divisions in the Laboratory. On March 14, 2001, a presentation was given to the Laboratory's University Relations Committee to highlight the educational approach and successes of our program. One of the results of this briefing was an invitation to give a presentation to a group of six undergraduates visiting from UNM to discuss the Laboratory mission, the role of the Seaborg Institute, this educational program, and actinide chemistry. This visit was organized by the High Explosives Group, DX-2 and included a tour of the explosives work site. From this presentation, an invitation was extended to present similar information to all student mentors in the Dynamic Experimentation (DX) Division on April 4 and 10, 2001. During these meetings, formal inclusion of a number of DX students into this program was made.

In order to continually improve the quality of the program, feedback from both UNM course surveys and custom-made course evaluations is being employed. These surveys seek input on the specific course topics, potential interest in additional classes in future years, the attitudes of the students toward actinide chemistry and the possibility of future career plans within actinide or nuclear science. In addition, we compiled a complete listing of e-mail addresses of all students participating in the courses, in order to track the future educational or employment endeavors of the students. This has enabled us to judge the potency this program has in stimulating interest among young scientists in the "Nuclear Future." This fiscal year we have begun to see the effect this educational program is having. We had four research fellows during our first year, FY99, two undergraduates and two graduate students. All four of these students have pursued careers in the nuclear science arenas. The two graduate students will be returning to the Laboratory as postdoctoral research associates, one of the undergraduate students is now at Stanford University in a Ph.D. program studying the behavior of uranium in the environment, and the other undergraduate has entered the Navy as a Nuclear Propulsion Officer. From the group of this year's Fellows, one of the undergraduate students has hired on as a full-time graduate research assistant, two of the graduate students will be returning to the Laboratory on a regular basis, and one undergraduate and one graduate will be returning next year to continue their independent research. We are extremely encouraged by these positive results, especially since all of the students have indicated that the experience with this program has guided their current pursuits in nuclear science.

The Research Fellows from the summer of 2001 all had an extremely productive time at the Laboratory, and a number of manuscripts have been published in this fiscal year:

(1) The Expanded Porphyrin Hexaphyrin(1.0.1.0.0.0): A Novel Ligand for the Complexation of Actinide Cations Uranyl ($UO_2^{+2}$) and Neptunyl ($NpO_2^{+}$); Jonathan L. Sessler, Daniel Seidel, Anne E. Vivian, Vincent Lynch, Brian L. Scott, and D. Webster Keogh, *Angew. Chemie. Int Ed. Eng.* 2001, *40*, 591-594.

(2) Synthesis and Structural Characterization of the Lanthanide Schiff-Base Complex, Michael Essig, D. Webster Keogh, Brian L. Scott, John G. Watkin, *Polyhedron* 2001, *20*, 373-377.

(3) A Model for Trivalent Actinides in High Carbonate-Containing Media: Structural Characterization of the Lanthanide Tetracarbonate $[Co(NH_3)_6][Na(\mu\text{-}H_2O)(H_2O)_4]_2[Ho(CO_3)_4] \cdot 4H_2O$; Deborah L. Bond, David L. Clark, Robert J. Donohoe, John C. Gordon, Pamela L. Gordon, D. Webster Keogh, Brian L. Scott, C. Drew Tait, and John G. Watkin, *European Journal of Inorganic Chemistry* 2001, 2921-2926.

(4) A Mechanistic Study of the Samarium(II) Mediated Reduction of Aryl Nitro Compounds to the Corresponding Aryl Amines. The Crystal Structures of $\{Sm[N(SiMe_3)_2]_2(thf)\}_2(\mu^2\text{-}O)$ and $[(Me_3Si)_2N]_2Sm(thf)(\mu\text{-}PhNNPh)Sm[N(SiMe_3)_2$; Erik D. Brady, David L. Clark, D. Webster Keogh, Brian L. Scott, John G. Watkin, *J. Am. Chem. Soc. Accepted.*

The Nuclear Weapons Mission of both Defense Programs and the Laboratory is to ensure confidence in the safety, reliability and performance of US nuclear weapons without nuclear testing. In the absence of nuclear testing, this requires a science-based approach to stockpile stewardship. Decisions must be made based on sound technical understanding and expert judgment developed through theory, experiment, and simulation. Therefore, one of the principal long-term issues facing the DP Laboratories is that of maintaining the quality of our scientific staff. Of grave concern is that a large fraction of Laboratory staff could retire within the next decade (42% of Laboratory technical staff are aged 50 or older), and their expertise and knowledge must be transferred to a new generation. From this

perspective, "Modern *f*-Element Chemistry" is one of the crucial components of the science and technology needed to reconstitute an underground nuclear testing or nuclear weapons production capability. It is sobering to recognize that virtually all of the Laboratory new hires over the past 20 years lack formal training in either this discipline or nuclear and radiochemistry. Our educational program is designed to provide overlap to transfer this corporate knowledge to current laboratory and DOE staff and to build a scientific base for future programmatic success. On page 29 of the Chiles Commission Report "Maintaining United States Nuclear Weapons Expertise," it is stated that "Post-doctoral, intern, and continuing education programs should be emphasized as especially important recruitment tools, and special emphasis should be placed on making the nuclear weapons complex an attractive place for women to work, given the increasing fraction of women in the scientific and engineering programs at American universities." A combined total of 91 students have registered for our workshops and summer course. In addition to the students enrolled at UNM-LA, local Albuquerque and distance-education sites coordinated through either the UNM or WERC systems led to the registration of students from UNM's Albuquerque campus, New Mexico Tech in Socorro, and Carlsbad Field Office. This course attracts a diverse audience representing a number of ethnic and minority groups. Over the three-year duration of this program, 40 of our students and Fellows have been women, representing 44% of our total enrollment. We are extremely pleased with the relatively high proportion of female students, technicians and postdocs who have signed up to take the *f*-element course, and we will strive to maintain this level of interest.

**The six Research Fellows, who joined the Laboratory this year, were:**

Cynthia Bolme – Junior at University of California, San Diego. Cyndi worked within the High Explosives Science and Technology group (DX-2). Cyndi's mentor for the summer was Dr. Steve Son. Their work focused on measuring the pressure dependence on the deflagration rates of high explosives. The secondary goal of the research was to investigate how cracks and other damage in explosives impact the deflagration.

Leilani Conradson – Senior at San Jose State University. Leilani took residence in the Nuclear Materials and Technology Division office. Her main responsibilities were the organization for scientific experiments at Stanford Synchrotron Source and program development for the Nanoscale Technology Conference. Leilani's summer mentor was Dr. David L. Clark.

Danielle Garcia – Graduate student at the University of New Mexico. Danielle is studying for a doctorate degree in pharmacy. Her interest in the fellowship program stemmed from the ability to work with analytical techniques for organic compounds. Danielle was mentored by Dr. Mary Campbell from the High Explosives Science and Technology group (DX-2). The exact work involved thermal analysis of explosives and their binders by dynamic mechanical analysis. The data they collected over the summer were used to support stockpile surveillance in analyzing whether lifetimes for the safe handling and reliable performance of the Stockpile can be determined and extended.

Anne E. Gorden – Graduate student from the University of Texas. Annie is in the doctoral program at the University of Texas in the Organic Chemistry department. Her mentor this summer was Dr. D. Webster Keogh from the Chemistry and Nuclear Materials Technology Divisions. Annie resided in the Structural Inorganic Chemistry (C-SIC) Group during the summer and will come back to the Laboratory in the spring of next year. Her research project for this summer consisted of synthesizing novel ligands for binding light actinide elements, uranium, neptunium and plutonium. The ligand systems she has been working with are expanded porphyrins. Annie has been able to show that by

varying the size of the cavity selectivity over not only the metal center but also the oxidation state. Her work has both applied and fundamental implications. Figure 16 shows UV-Vis-NIR spectra of the free ligand isoamethyrin and once it is bound to Np(V). A crystal structure of the metal complex is also shown. These expanded porphyrin ligands are intensely colored with molar extinction coefficients in the hundreds of thousands and dramatic changes in the color occur when a metal is complexed. As a result colorimetric indicator systems could eventually be developed around this technology to detect actinide contamination down to 0.1 mM.

Piyush Shukla – Graduate student from the University of Texas. Dr. John Gordon from the Chemistry Division mentored Piyush this past summer. As a result of Piyush's hard work and enthusiasm, a permanent collaboration between Dr. Gordon and Prof. Alan Cowley, Piyush's graduate advisor, has been established. Piyush worked in the area of main group chemistry, developing concepts and new ligand systems, which will be applicable to lanthanide and actinide chemistry.

Recently there has been a great deal of interest in using (aromatic) diimine ligands to support complexes capable of promoting new C-H activation and olefin polymerization chemistries. Traditionally, aromatic diimines are generated via the reaction between an aniline and a diketone (in the presence of a dehydrating agent). We are particularly interested in accessing diimine ligands that contain perfluorinated aromatic groups, since these should confer a high degree of electrophilicity at the metal centers we choose to study. This general class of ligand appears to largely inaccessible by traditional methods (due to the lack of nucleophilic character of the anilines). As an alternative synthetic approach, Piyush investigated the chemistry of aluminum complexes containing anilido fragments and their application in the synthesis of new diimines. Not only did he prepare and characterize several new organometallics, but he also demonstrated the potential utility of the

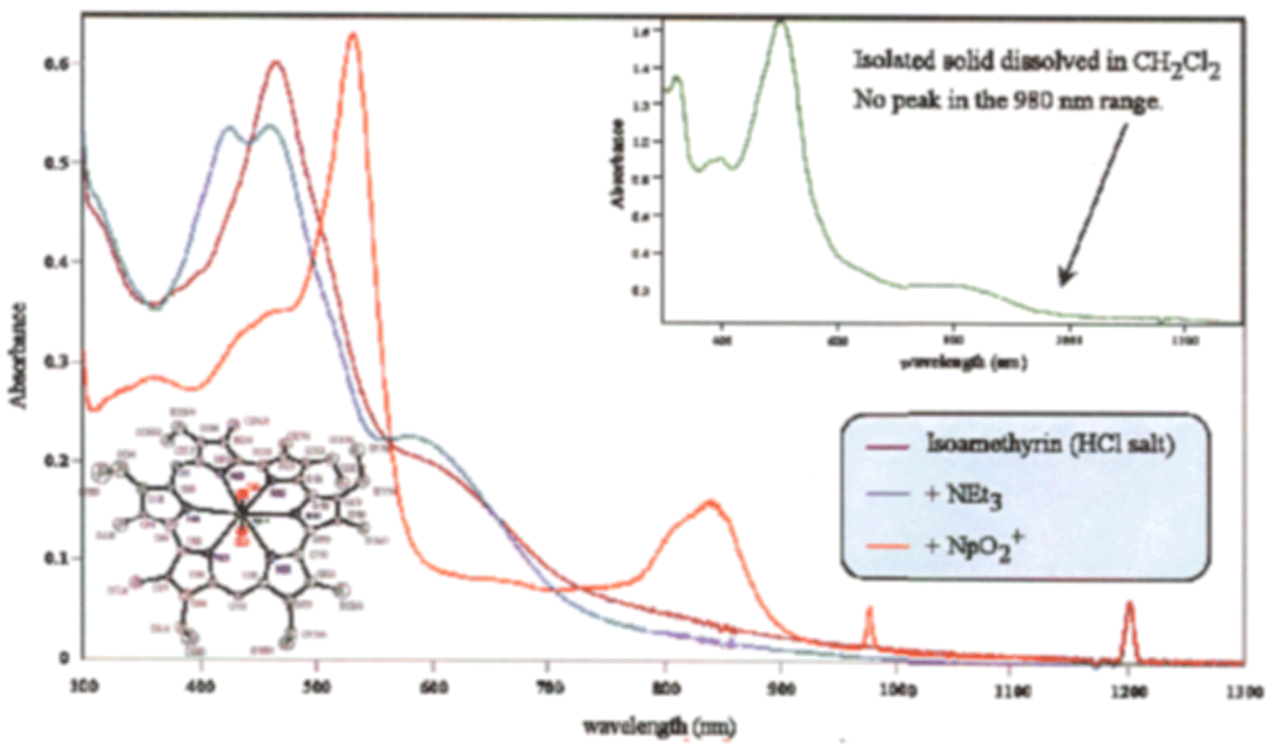



*Figure 16. UV-Vis-NIR spectra of the free ligand isoamethyrin.*

method in the synthesis of a number of new a-diimine, b-diimine and b-ketimine ligands that we plan to use in the synthesis of new complexes of the p, d and f-block elements.

Bridget Williams – Undergraduate student from Colorado State University. Bridget joined Los Alamos National Laboratory as a student scientist to pursue fundamental research of the lanthanide and actinide elements. Bridget is motivated to become a leader in this field and has chosen to continue her research at Los Alamos for the remainder of the 2001/02 academic year. She will begin her graduate research and education in chemistry at the University of Wisconsin beginning in the fall of 2002. Bridget has been mentored in her work by Dr. Warren J. Oldham, a staff scientist in the Nuclear Materials Technology Division. Bridget's work is motivated by a desire to develop sustainable and nonpolluting chemical technology for actinide recovery and purification. In this effort Bridget has explored the behavior of metal complexes in novel, environmentally benign solvents called room-temperature ionic liquids. Room-temperature ionic liquids are low-melting (below room temperature) organic salts composed of organic cations and weakly coordinating anions. The perception of ionic liquids as "green" solvents is based principally on their nonvolatility and significantly reduced flammability hazard compared to more familiar organic solvents (Fig. 17). Ionic liquids may also promote interesting and distinctly different reaction chemistry promoted by a novel and easily manipulated chemical environment. Ionic liquids are capable of solvating and stabilizing highly charged metal species, while maintaining good solubility of nonpolar organic materials. The distinctive ionic character of these solvents also provides highly electrically conductive media that can be exploited in electrochemical applications. Bridget is working to characterize the basic coordination chemistry and electrochemical behavior of lanthanide and actinide complexes in the ionic liquid medium. Her work will form the scientific basis of advanced, next generation, sustainable nuclear technology.

## Future Plans

### Technician and Student Development

We will be distributing an announcement for the future courses and workshops to students, postdocs and technicians who work within the Chemistry, Nuclear Materials Technology,

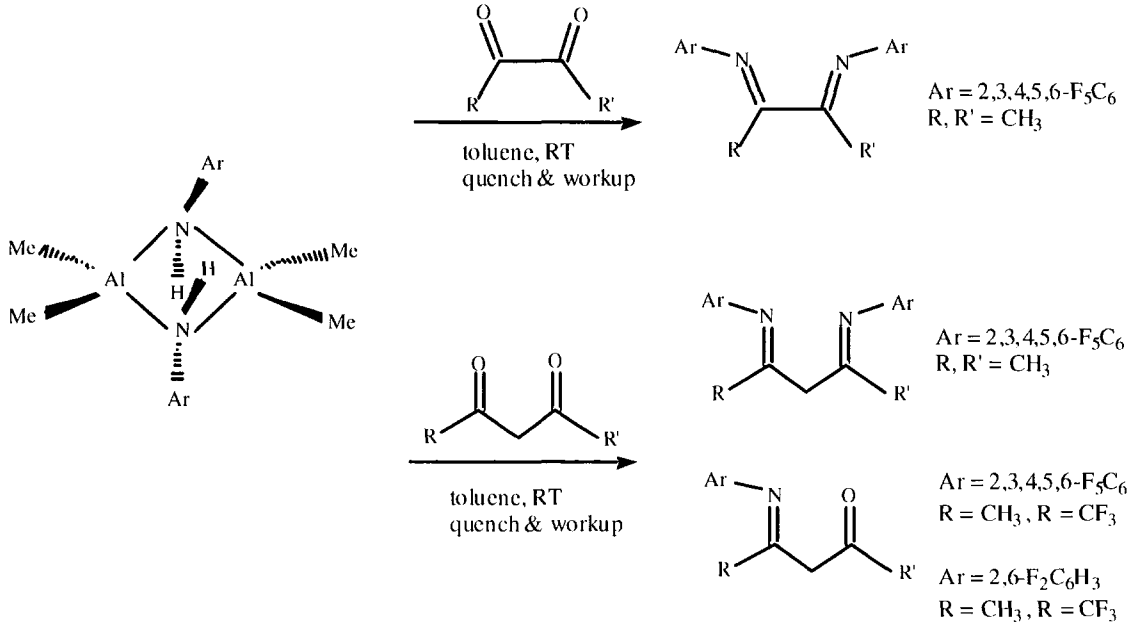



*Figure 17. Ionic character of "green" solvents.*

Materials Science Technology, and Explosives Divisions at the Laboratory. The announcements will be posted on both the Laboratory's student and postdoc Web pages so that they will be available to all incoming students. We have previously had extremely positive responses to the course announcement from many Laboratory employees, and a significant number have registered to take the course.

**Short Course, Workshop, and Seminar Series**
As mentioned above, satellite broadcast testing for short courses, workshops and seminar series was performed during the months of June and July 2001. Future programs will be run as frequently as possible with a target of at least one per month. The current topics under consideration for these presentations are Plutonium Metallurgy, Spectroscopic Techniques in Actinide Chemistry, and Separations Science.

## Summary

We have described the activities, which have taken place in FY01 for this program as well as comprehensive data encompassing the first three years. Our intention is to expand the scope of the program to the point at which students will be able to take fully-accredited courses not only in *f*-element chemistry, but also in closely allied subjects such as plutonium metallurgy, environmental actinide chemistry, physical methods and interfacial actinide science.

Institutions represented by students participating in Nuclear Science Education for the 21st Century: Modern *f*-Element Chemistry.

University of New Mexico
New Mexico State University
University of California, San Diego
San Jose State University
University of Texas
Colorado State University

# Nuclear and Radiochemistry

## Program Description

This project continues an introductory undergraduate/graduate-level course, which is focused exclusively on nuclear and radiochemisty. The program, which is fully accredited by the University of New Mexico (UNM), features both a lecture course and selective research fellowships, and is coordinated through the Seaborg Institute for Transactinium Science (ITS). The lecture course was presented during the spring and summer semesters at UNM-Los Alamos (UNM-LA). The lectures provide an introduction to nuclear and radiochemistry, areas in which most university facilities lack the expertise. The 12-week summer research fellowships entailed participation in both the lecture course and an independent research project.

## Performance Objectives and Milestones

The objective for designing and offering this course is to continue development of an internationally recognized and greatly needed educational program which will (1) serve as a national resource for the teaching of nuclear sciences, (2) provide a vehicle for early recruitment of the next generation of nuclear scientists and engineers, (3) offer accredited courses which can expedite a student's graduation, (4) increase the Laboratory's staff involvement in nuclear science outreach activities, and (5) provide a mechanism for the career development of the Laboratory's, DOE's and the National Nuclear Security Administration's (NNSA's) staff and technicians. We are hopeful that this program will continue to grow in subsequent years and lead to the establishment of a number of similar educational curricula in related disciplines, e.g., nuclear materials science and environmental science. At the conclusion of the course the students acquired a greater appreciation of the diverse use of the principles of nuclear and radiochemistry in nuclear energy, national defense activities, and legacy cleanup. With this insight, together with the introduction to the extensive research facilities available at national laboratories, we hope these talented young researchers will be stimulated toward a career in nuclear and weapon-based science. All previous milestones listed in our proposals including Fellows search, presenting the course, and research presentations were realized, and we are continuing this trend in the current fiscal year. In addition, we are continuing to expand and adapt the program to access larger groups of students, staff, and technicians.

## Highlights of Year's Accomplishments

We detail below our progress for the 2001 fiscal year on three separate projects: (1) the lecture course at the Laboratory; (2) sponsoring of research fellows in nuclear and radiochemistry science during the summer of 2001; and (3) increasing outreach activities for Laboratory staff. It should be noted that a majority of our activities occurred during the summer, leaving the first half of the year for planning and development. In general support of educational efforts in nuclear science, the Laboratory has established and funded a new position within the Seaborg Institute, Associate Director for Education. Dr. D. Webster Keogh has accepted the position.

(1) Dr. Moses Attrep taught the "Nuclear and Radiochemistry" course at UNM-LA twice in this last fiscal year, one each in the spring and summer semesters. There were a total of 26 people enrolled at UNM-LA: students, technicians, and staff members from the Security, Chemistry and Nuclear Materials Technology Divisions in the Laboratory. In addition, four

students from the Waste Isolation Pilot Plant (WIPP) were enrolled in the course and used distance-learning technology to take the class. The collaboration with the broadcasting personnel at the Waste-management Education and Research Consortium (WERC) site at New Mexico State University continued this year, where a re-broadcast of the signal via satellite was sent to downlink sites around the country.

(2) In December 2000, we distributed posters to approximately 125 chemistry departments nationwide announcing our intention to fund six Seaborg Institute Research Fellows during the summer of 2001. We also have updated and maintained our Website (http://pearl1.lanl.gov/seaborg) to provide information about the Seaborg Institute and its educational programs as well as to allow fellowship applicants to apply online. The deadline for applications was March 1st. The selected candidates were composed of two senior undergraduates (from the University of Wyoming and Texas Tech University), and two graduate students (from the University of Missouri and the University of Chicago). The Fellows were at the Laboratory for 10–12 weeks, starting in June 2001. They attended the "Nuclear and Radiochemistry" course in addition to performing independent research under the guidance of the Laboratory scientists. During their summer research, they gave oral presentations of their work at weekly meetings to groups of staff, postdocs, and fellow students. Tours and demonstrations were also organized this year of TA-55, the plutonium processing facility, and a destruct shot (500-pound explosive test).

(3) In March 2001, we purchased satellite time for the months of June and July 2001. This purchase provided our programs access to the same satellite 24 hours a day seven days a week during the prescribed months. This access enhanced our ability to reach other universities, DOE, and NNSA sites by simplifying the receipt of our broadcasts to a single satellite position. Within these complexes, a variety of people exist with differing time constraints as well as educational backgrounds and needs. In order to accommodate these people, we tested the use of this satellite time for the sponsoring of future short courses, workshops and seminar series in nuclear and weapons-related sciences. The different educational approaches are designed to target the various audiences, maximizing information exchange while minimizing time requirements. In order to promote the program Dr. Attrep visited the WIPP site on February 22–23, 2001. Contacts were also made with Lawrence Livermore National Laboratory, Clemson University, the University of Missouri, MIT, and Florida State University.

In order to continually improve the quality of the program, feedback from both UNM course surveys and custom-made course evaluations was employed. These surveys seek input on the specific course topics, potential interest in additional classes in future years, the attitudes of the students toward actinide chemistry, and the possibility of future career plans within actinide or nuclear science. In addition, we are compiling complete listings of e-mail addresses of all students participating in the courses in order to track the future educational or employment endeavors of the students. This has enabled us to judge the potency this program has in stimulating interest among young scientists in the "nuclear future."

The Laboratory and NNSA Defense Programs have a mission in nuclear weapons to ensure confidence in the safety, reliability and performance of US nuclear weapons without nuclear testing. In the absence of nuclear testing, this requires a science-based approach to stockpile stewardship supported by a broad range of science and technology capabilities. Decisions must be made based on sound technical understanding and expert judgment developed through theory, experiment, and simulation. It is abundantly clear that our understanding of the science of nuclear weapons and the effects of aging and manufacturing must be preserved. Therefore, one of the principal long-term issues facing the DP

laboratories is that of maintaining the quality of our scientific and engineering staff. Of grave concern is that a large fraction of the Laboratory staff could retire within the next decade (42% of LANL technical staff are aged 50 or older), and their expertise and knowledge must be transferred to a new generation. From this perspective, nuclear and radiochemistry is a crucial component of the science and technology needed to reconstitute an underground nuclear testing or nuclear weapons production capability if the Laboratory is called upon to do so by national security requirements. It is sobering to recognize that virtually all of the Los Alamos students and new hires over the past 10–20 years lack formal training in both modern *f*-element chemistry and nuclear and radiochemistry, and most of what they have learned has been through informal mentoring or by hands-on experience. Surely, other DP laboratories are facing a similar situation, and we are exploring ways to work with them. Our educational program is designed to provide overlap to transfer this corporate knowledge in a formal classroom setting and build a scientific base for future programmatic success. On page 29 of the Chiles Commission Report "Maintaining United States Nuclear Weapons Expertise," it is stated that "Post-doctoral, intern, and continuing education programs should be emphasized as especially important recruitment tools, and special emphasis should be placed on making the nuclear weapons complex an attractive place for women to work, given the increasing fraction of women in the scientific and engineering programs at American universities." A combined total of 115 students have registered for our workshops and summer course. In addition to the students enrolled at UNM-LA, local Albuquerque and distance-education sites coordinated through either the UNM or WERC systems led to the registration of students from UNM's Albuquerque campus, New Mexico Tech in Socorro, and the Carlsbad Field Office. This course attracts a diverse audience representing a number of ethnic and minority groups.

**Technician and Student Development**
We will continue distributing announcements for courses and workshops to the students, postdocs, and technicians who work within the Chemistry, Nuclear Materials Technology, Materials Science Technology, and Explosives Divisions at the Laboratory. The course announcements this year were posted on both the student and postdoc pages on the Laboratory's Website so that it was seen by all of the incoming students this summer. We have previously had extremely positive responses to the courses from many Laboratory employees, and a significant number registered to take the course.

## The four Research Fellows, who joined the Laboratory this fiscal year, were

**Student**: Thomas Marrero, graduate student, University of Missouri-Columbia
**Mentors**: Drs. Moses Attrep and Norman Schroeder, Chemistry Division (C-INC)

The purpose of Tom's work was to determine the optimum conditions for the removal of radioiodine from simulant dissolver solutions. Iodine-129 is of particular interest because of the unfavorable risk assessments for storage. The collected 129I will be collected and converted to the chemical form where it will be transmuted from 129I to 130Xe by neutron capture in a high-flux neutron source.

Tom investigated iodine chemistry in aqueous solutions and chemical capture methods for fission-produced iodine at nuclear waste treatment facilities. An equilibrium-based model to predict the iodine chemistry includes the various forms of iodine compounds, I2, I-, IO3-, etc., and the effects of ionic strength, nitric acid concentration, temperature, and nitrogen gas flow that remove iodine from aqueous solutions. Bench-scale experiments set the parameters for removing the iodine under the shortest time with the simulant used.

**Student**: Arif Ali, Pritzker graduate student, University of Chicago
**Mentor**: Dr. Steve Son, High Explosives Science and Technology Group (DX-2)

Arif worked on numerous projects at the Laboratory. One of the projects that was brought to completion involved the investigation of the ignition properties of various high explosives. In order to accomplish this goal, a $CO_2$ laser was used to thermally excite the high explosive, and a number of diagnostic instruments were used to study the phenomenon. Of particular note was the use of second harmonic generations to investigate various aspects of the ignition process.

A second project on which Arif has worked was the design of a new rocket thrust stand. The purpose for this stand was to test advanced, low-signature propellants being developed within the Laboratory. A majority of this summer's work focused on measuring the pressure dependence on the deflagration rates of high explosives.

**Student**: Sarah Turner, undergraduate student, University of Wyoming
**Mentor**: Dr. Robert L. Bishop, High Explosives Science and Technology Group (DX-2)

Sarah worked within the High Explosives Science and Technology group (DX-2). Her research project centered around the chemical properties of a variety of high explosives. Similar work in that area, that has been previously done, includes the chemical destruction of high explosives using base hydrolysis.

**Student**: Bryan Bockmon, undergraduate student, Texas Tech University
**Mentors**: Dr. Steve Son, High Explosives Science and Technology Group (DX-2) and Prof. Michelle Pantoya (Texas Tech University)

Bryan had the good fortune of being involved with a collaborative project between his research advisor at Texas Tech and a technical staff member from the Laboratory. At Texas Tech, Bryan had conducted flow-visualization research. The underwater flow-visualization experiments consisted of gathering video data of flow patterns across a plain cylinder under specific conditions. Bryan used this background at the Laboratory by filming and analyzing a number of explosive test shots. The equipment used was highly specialized and has provided a basic understanding of shock wave evolution.

Bryan also helped in the development of a system to study the progression of burning explosives. This project consisted of designing and constructing a reaction chamber to gather combustion data on new pyrotechnic and explosive materials. He spent a good part of this summer running experiments in this chamber and analyzing the gas products.

## Future Plans

### Staff Development

As indicated in the demographics of all of the Defense Programs' laboratories, the work force is aging significantly. The effect of this aging work force has now directly impacted this program. One of the professors, Dr. Thompson, has retired from the Laboratory and was not be able to teach the class in the summer. As a result Dr. Attrep will be mentoring a new staff member to co-teach the course.

### Short Course, Workshop, and Seminar Series

As mentioned above, satellite broadcasting of short courses, workshops and seminar series were tested during the months of June and July 2001. Due to the positive results of these tests, new educational programs will be run as frequently as possible with an initial target of one per month. The current topics under consideration for these presentations are statistics, radionuclides in the environment, and nuclear and radiochemistry.

## Summary

We have described the activities, which have taken place in FY01 for this program as well as comprehensive data encompassing the first two years. Our intention is to expand the scope of the program to the point at which students will be able to take fully-accredited courses not only in nuclear and radiochemistry, but also in closely allied subjects such as statistics and environmental chemistry.

Institutions represented by students participating in Nuclear Science Education for the21st Century: Nuclear and Radiochemistry.

University of New Mexico
New Mexico State University
University of Chicago
University of Missouri
University of Wyoming
Texas Tech University
Waste Isolation Pilot Plant

# Section 2

# Student Internships and Co-ops

Supported by the
Department of Energy
Office of Defense Programs

# Student Programs: Internships and Cooperative Educational Experiences

## Program Description

FY01 brought about many interesting challenges and changes for Science and Technology Base Programs—Education Programs Office (STB-EPO). The Education Programs Office was given institutional and programmatic oversight of student programs which consist of the High School Co-operative, Undergraduate, Graduate and College Co-operative education programs. Along with the programmatic transition was the addition of a newly created position, the Laboratory Student/Mentor Liaison. One of the primary objectives of this new team is to plan, prepare, and provide student participants with a quality and rewarding work experience. This team partners with internal and external resources including mentors, student liaisons, students, management, and the community. Information/feedback about student-related experiences and issues are being collected and tracked. This data will be utilized for further marketing and outreach efforts to help attract and retain student program participants, which is a primary institutional goal of the Laboratory. The data will also be used to conduct lessons learned and formulate process improvements. STB-EPO also oversees the Student Association and works directly with the Student Programs Advisory Council (SPAC). The Laboratory had approximately 1,500 students during summer 2001. This number is expected to increase to 1,600 in summer 2002. (See Chart 4.)

**Students by Month**

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HS | **72** | **75** | 76 | 77 | 79 | 80 | 81 | 72 | 59 | 66 | 71 | 75 |
| UGS | 827 | 827 | 818 | 818 | 806 | 796 | 779 | 848 | 770 | 930 | 919 | 905 |
| GRA | 333 | 324 | 319 | 318 | 320 | 311 | 311 | 364 | 379 | 391 | 369 | 362 |
| Total | 1232 | 1226 | 1213 | 1204 | 1205 | 1187 | 1171 | 1284 | 1354 | 1387 | 1359 | 1342 |

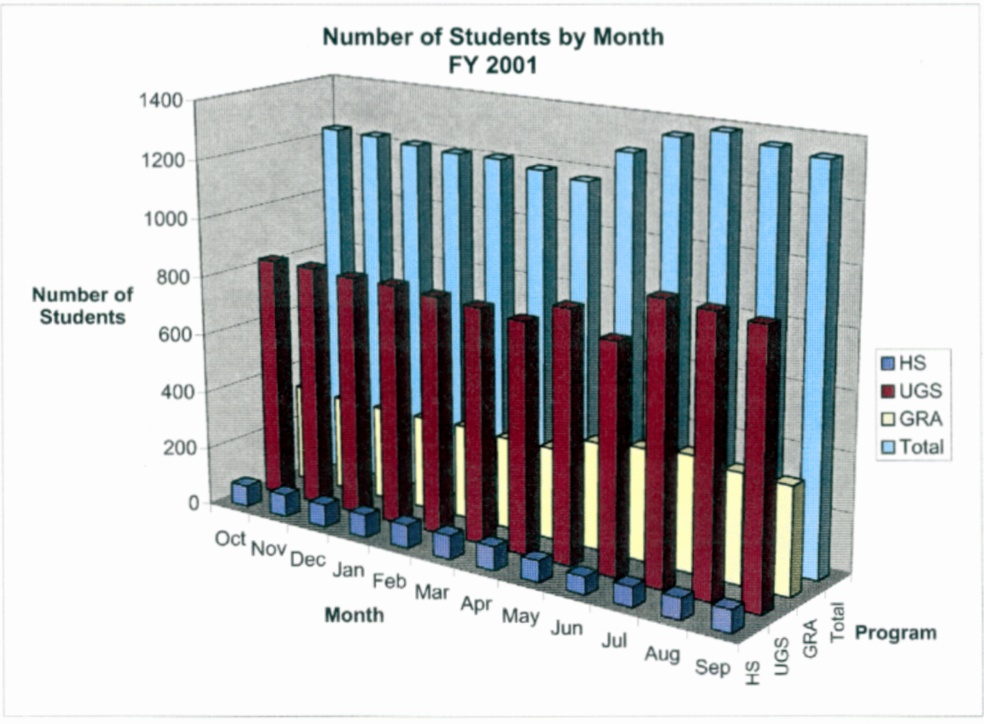



*Chart 4. LANL student population.*

## University of Colorado at Boulder Formative Evaluation

Along with the transition of student programs came a formative evaluation that was conducted by the University of Colorado at Boulder. The focus of the evaluation was student internship programs. The information provided feedback to student programs staff, partners, and participants on the efficacy of many aspects of student programs, as they are perceived by three years of interns (1998–2000). The report findings came from Student Programs Advisory Council and the Continuous Quality Improvement (CQI) Committee minutes, student survey data, intern write-in comments from student surveys, and interviews with undergraduate and graduate program interns. The evaluation findings have been useful in guiding student program staff about needed program and design changes as well as the need to implement an evaluation tool to monitor the impact of program changes. A triangulated method was used, gathering quantitative and qualitative findings as well as quotations from the interview data. This evaluation has been an important tool and has been a valuable guide for this new team. The team has focused on making data-driven decisions and changes when addressing program needs.

## High School Co-operative Program

Qualified high school seniors are provided the opportunity to develop skills and gain work experience, while receiving exposure to a variety of technical and administrative career fields. As an educational program, it is designed to complement the students' education with work experience related to their chosen fields of study while assisting them with the school-to-work transition. The participating high schools establish eligibility criteria for students to receive credit and screen the students for aptitudes and interests, grade point average, and number of credits toward graduation. Students who are from other area high schools or alternative schooling are also encouraged to apply with their guidance counselor's approval. Participants have the opportunity to work full time during the summer between the junior and senior year, and may continue the appointment in part-time status during the academic year. Scheduled campus visits and presentations are conducted each spring and fall in an effort to continue successful recruitment of eligible students, as evidenced by the number of applicants selected for the year. Currently, students from 10 area high schools participate in the program. The total number of high school students participating in FY01 increased from previous years. There were approximately 143 total participants: 57% Hispanic, 1% Asian, 6% Native American, 30% White, and 6% that did not specify (see Chart 5). The growth and development of this precollege program will continue through enhanced recruitment with additional campuses to encourage northern New Mexico students to pursue their educational and academic achievements through access to learning opportunities within the Laboratory.

## Undergraduate Program

The Undergraduate Student (UGS) Program consists of summer, part-time, and full-time appointments for undergraduate students. The educational program is year-round and provides students with relevant research experience while they are pursuing undergraduate degrees. Eligibility is limited to those students who have completed high school and are admitted and in active status in an undergraduate program. Appointments are available both in the technical and administrative fields for 90-day summer internships with the option to continue working part-time during the academic year. Maximum years in the program are six years for those pursuing a bachelor's degree and three years maximum for those pursuing an associate degree. There is also the post baccalaureate category of the UGS program that offers college graduates the opportunity to participate in the program a maximum of one year after graduation. This category applies to those students who

**Number of High School Co-Op Students**

| | N Am | As Am | Black | Hispanic | White | Other |
|---|---|---|---|---|---|---|
| Female | 3 | 0 | 0 | 67 | 18 | 2 |
| Male | 5 | 2 | 0 | 14 | 25 | 6 |
| Total | 8 | 2 | 0 | 81 | 43 | 8 |

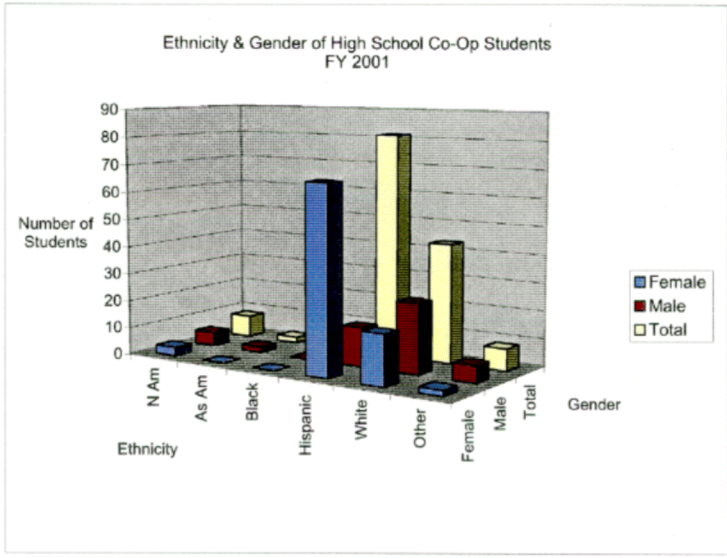



*Chart 5. High school distribution.*

have been awarded a bachelor's degree but have not yet been accepted and enrolled in a graduate program. Post baccalaureate students are encouraged to take class(es) during this year and may move into graduate status when documentation is provided indicating acceptance and enrollment into a graduate program.

Currently, students from 1203 colleges and universities participate in the UGS Program. During FY01 2,063 UGS applications were received. Of these, approximately 1,211 were selected for internships with a composition of 39% Hispanic, 3% Asian, 3% Native American, 1% Black, 48% White, and 5% did not specify (see Chart 6). There were 16 undergraduate student conversions to Laboratory staff positions; 63% were Hispanic, 6% Native American, and 31% White participants (see Chart 7). Students with unique skills and qualifications may be converted to both technical and administrative Laboratory staff positions. The strategic recruiting effort to help increase the diversity of Los Alamos National Laboratory's entry level work force pool continued in FY01, by developing partnerships and creating programs with various campuses throughout the nation.

The number of students participating in internships has fluctuated over the last four years.

In 1998, there were 1,445 students: 6% HS Co-op, 62% UGS, and 32% Graduate Research Assistants (GRAs).

1999 saw a slight 6% drop to 1,355 resulting in 5% HS Co-op, 67% UGS, and 28% GRAs.

In 2000, there was an additional 9% drop due to the fire, to 1,238 resulting in 5% HS Co-op, 67% UGS, and 27% GRAs.

In contrast, FY 2001 saw a 33% surge overall, to a total of 1859 students: 8% were HS Co-op, 65% were UGS, and 27% were GRAs.

Despite the variation in numbers, the overall percentages between categories appear to have remained relatively the same (see Charts 8 and 9).

**Number of Undergraduate Students by Ethnicity**

| | N Am | As Am | Black | Hispanic | White | Other |
|---|---|---|---|---|---|---|
| Female | 16 | 17 | 4 | 259 | 251 | 20 |
| Male | 18 | 18 | 14 | 221 | 333 | 40 |
| Total | 34 | 35 | 18 | 480 | 584 | 60 |

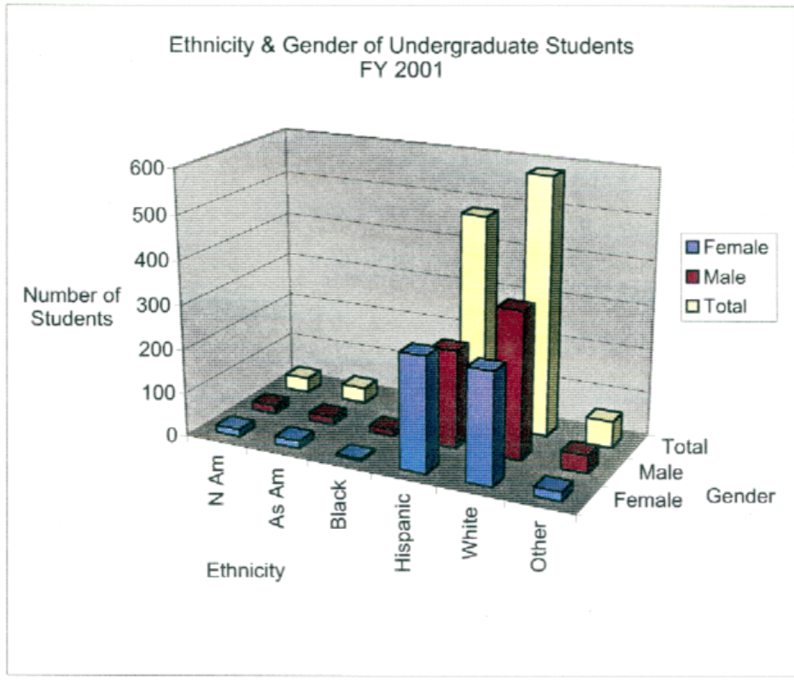



*Chart 6. Undergraduate distribution.*

**Students Converted**

| | Hispanic | NA | White | Other |
|---|---|---|---|---|
| GRA | **5** | **1** | **11** | **2** |
| UGS | **10** | **1** | **5** | |
| Total | **15** | **2** | **16** | **2** |

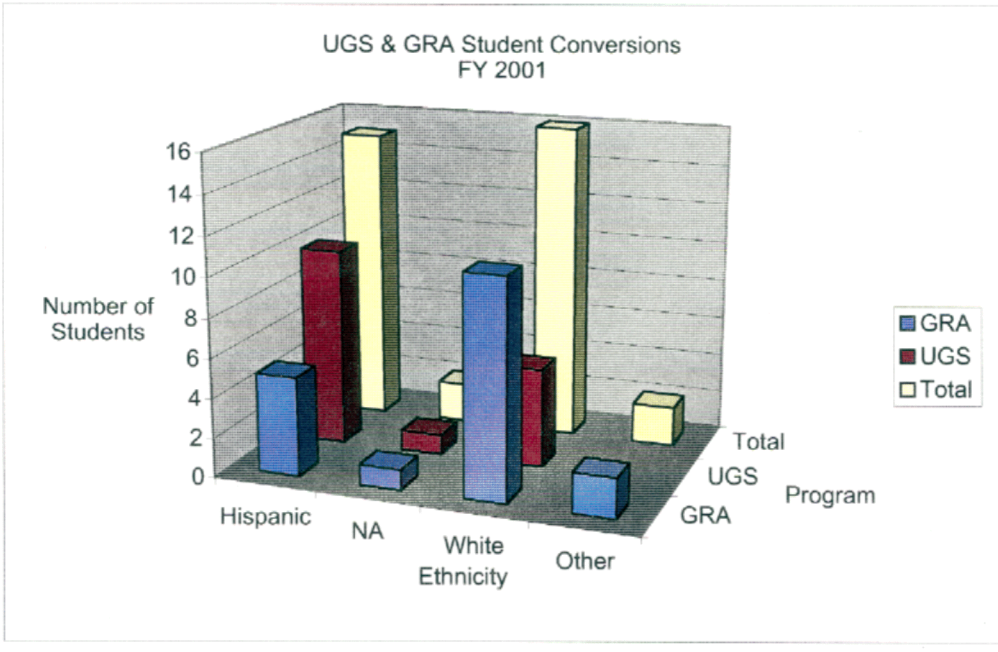



*Chart 7. Undergraduate and graduate conversions.*

**Four Year Trend**

| | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|
| HS | 88 | 68 | 66 | 143 |
| UGS | 896 | 904 | 832 | 1,211 |
| GRA | 461 | 383 | 340 | 499 |
| Total | 1,445 | 1,355 | 1,238 | 1,853 |

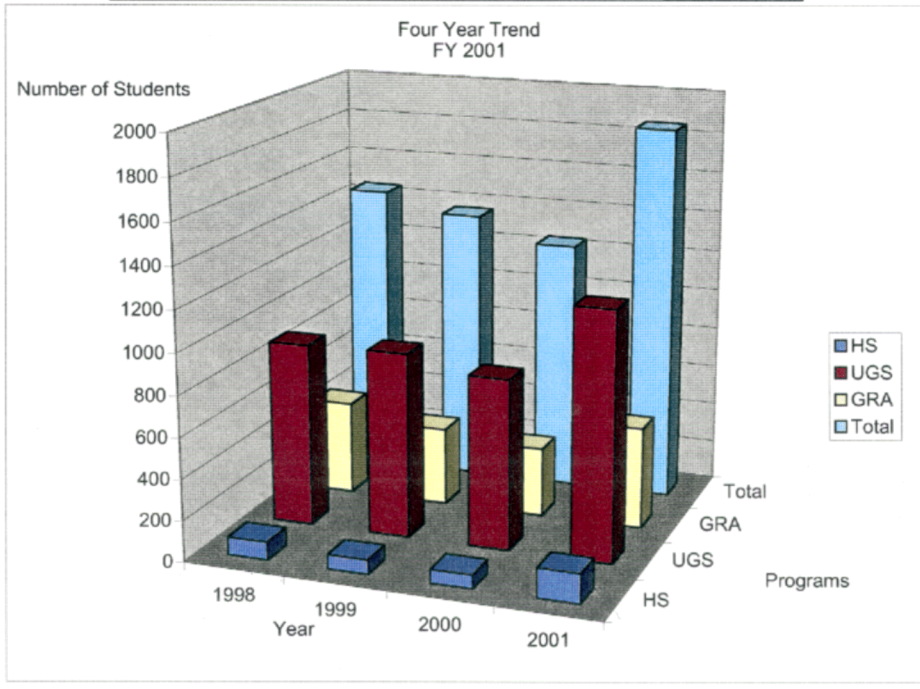



*Chart 8. Type of appointment by reporting period.*

**Number of Graduate Research Assistants**

| | N Am | As Am | Black | Hispanic | White | Other |
|---|---|---|---|---|---|---|
| Female | 5 | 19 | 7 | 25 | 97 | 12 |
| Male | 2 | 37 | 8 | 26 | 227 | 37 |
| Total | 7 | 56 | 15 | 51 | 324 | 49 |

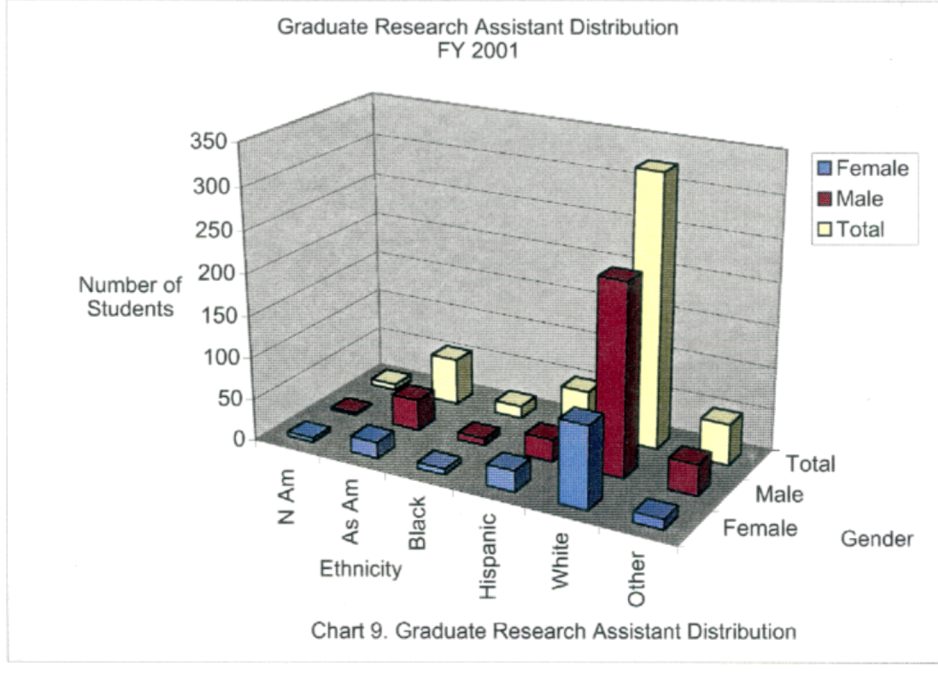



*Chart 9. GRA distribution.*

## Graduate Research Program Description

The Graduate Research Assistant (GRA) Program is a year-round educational program that provides students with relevant research experience while they are pursuing a graduate degree program. Los Alamos National Laboratory appoints graduate students from across the world to experience the unique internships in basic and applied research work at Los Alamos. Currently, students from 168 colleges and universities participate in the GRA Program. To qualify, candidates must have proof of good academic standing from their institution, must hold a bachelor's degree, and must be actively enrolled in a graduate program. Appointments are available both in the technical and administrative fields for 90-day summer internships with the option to continue working part-time during the academic year. The maximum number of years allowed in the program is dependent on the type of degree held and the type of graduate degree being pursued. Students are selected on the basis of field of study, academic standing with their institution, and research interests.

During FY01, 584 applications were received. Of these, approximately 506 were selected for internships with a composition of 39% Hispanic, 3% Asian, 3% Native American, 1% Black, 48% White, and 5% did not specify (see Chart 6). There were 19 graduate student conversions; 26% were Hispanic, 5% Native American, 58% White, and 11% did not specify (see Chart 8). Students with unique skills and qualifications may be converted to both technical and administrative Laboratory staff positions. The effort to help increase the diversity of Los Alamos National Laboratory's entry level work force pool continued, with focused and strategic student recruitment at various campuses throughout the nation.

## Student Program Highlights

Among the many activities/functions that were held were mentor training; student liaison training; new student orientation; a weekly electronic newsletter for mentors and liaisons; tracking of student work plans; the All-Student Picnic with a LANL Information Fair (Fig. 18); a bi-weekly Student Breakfast Seminar for students; coordination of All Student Meetings with the Student Programs Advisory Council (SPAC). Bill Press, Deputy Director, and John Browne, Laboratory Director, assisted with the coordination of the first annual Symposium (Fig. 19) and oversight and advisement of the Student Association. Other activities/initiatives include the Student Postings Initiative, an international gathering for graduate students (Fig. 20), student discount cards, and the Distinguished Student Performance Awards. The following information details programmatic information.

## Student Breakfast Seminar

This was a pilot year for the Student Breakfast Seminar. The intent of the seminars was three-

*Figure 18. Student picnic.*

*Figure 19. Symposium awards.*

*Figure 20. International gathering. GRA Program Coordinator Kari Lier talks with graduate student Andreas Rechtsteiner at the Graduate Student Gathering hosted by STB-EPO. Inset photo, Anh Trinh Nguyen is dressed in her native dress. Ms.Nguyen was a guest of a student participant.*

fold: to bring the students together on a regular basis to learn about LANL resources, a means of providing ongoing feedback to student programs, and the opportunity for students to socialize. The breakfasts were held every other Thursday morning. Each session began with a brief presentation about LANL resources i.e., Research Library, safety and security, Human Resources, etc. Questions and comments were then submitted by students regarding their concerns and/or needs, and the remaining time was spent with the students socializing with each other. The attendance averaged 15 students. The students who attended enjoyed the sessions and found them to be helpful in learning more about the Laboratory. The students suggested that the mentors or the Laboratory support them by paying for their breakfasts. The breakfast seminars will continue next year, and an effort will be made to seek sponsorship by various Laboratory organizations to pay for the refreshments.

## All Student Picnic with Information Fair

The All-Student Picnic with the Information Fair was held June 7, at Urban Park. EPO hosted the picnic that previously has been sponsored by the Student Association. The addition of the Information Fair was well received at the picnic. Various Laboratory organizations and partners included the Ombudsman Office, Wellness Center, Community Relations Office, LANL Foundation, Human Resources, Housing Office, Environment Safety and Health-2 and the Research Library; all staffed booths provided students with information about their respective organizations. During the event, the Community Relations Office distributed community-sponsored discount cards to students. EPO staff served food to over 700 students, mentors and liaisons. The students praised the Information Fair and found it useful in learning more about the Laboratory.

## Proactive All Student Meetings

Three all-student meetings were held: with the Student Programs Advisory Council (SPAC) on June 21, 2001; John Browne, Laboratory Director, on July 11, 2001; and Bill Press, Deputy Director Science and Technology on August 7, 2001. The meetings were held to address student concerns and issues regarding the Laboratory and

the community. Each meeting began with a brief presentation about the importance and value of students followed by questions from students. Each meeting was well attended. The issues addressed focused primarily on student housing, transportation, lack of social life after work hours, and the cost of living. As a result of these meetings, many committees and sub-committees have developed to improve the overall student experience.

## Student Association

Reviving and redefining the Student Association was a primary goal for Summer 2001. Student elections were held, new members were named, a new charter was implemented, and the organization began to recreate itself. The need to redefine the Student Association became necessary, as attendance and participation had dropped to a degree where the Student Association was virtually nonexistent. The Student Association was mentored and guided by EPO and SPAC. The new Student Association has worked diligently to meet student needs by implementing a new student information list service, creating a new Website, and by sponsoring activities that create more visibility for the organization and are more in line with all student needs. Various committees are in place to address student issues and to prepare for fiscal year 2002. A great amount of attention is being given to students who continue to work with the Laboratory year-round. Communication is a primary focus for the new Student Association. As a result, representatives attend the biweekly meetings with SPAC and interact regularly with their advisors.

## Symposium 2001

The Symposium was held on August 5–6, 2001, at the Santa Fe Community College. This year's first annual symposium had 101 UGS and GRA student and postdoctoral entries, with an additional 200 attendees. Thirty-four students presented formal technical papers (Fig. 19), 60 students presented posters, and seven participants were in the postdoctoral category. The categories represented included biology, chemistry, materials science, numerical analysis, environmental science, and physics. Laboratory technical staff, affiliates, retirees, and academic professionals judged the presentations. The intent of the Symposium and Career Fair was to broaden the students' and postdoctoral appointees' expertise and prepare them for careers in engineering and science. Sponsors commented favorably on the purpose, scheduling, and organization of the event. Students also commented favorably on the immediate feedback they received on their presentations.
The event was followed by an awards banquet at which Laboratory Director John Browne presented the awards.

## GRA International Gathering

On July 17, 2001, the EPO hosted the first GRA International Gathering (Fig. 20). This function was designed to further diversity awareness and enhance communications among the GRA students. Over 60 students were in attendance. The participants represented France, Sweden, Germany, China, Japan, Canada, Nigeria, Colombia, Greece, Cuba, Mexico, Portugal, Romania, the Netherlands, and several others. Many of the students actually were from these countries, while others just represented a country with food and greetings.

*Figure 21. Greg Day is an MST-6 graduate student, who received the Symposium 2001 Award for Overall Best Graduate Poster.*

# Section 3

# Science Education Programs

Supported by the
Department of Energy
Office of Defense Programs

# College Co-op Program

## Program Description

The College Co-op Program, established in FY01, is designed to provide a unique and challenging off-campus research opportunity for university undergraduate students in science, mathematics, computer science, and engineering. Patterned after the Laboratory's successful MIT Engineering Internship Program and the former DOE/DP Undergraduate Research Semester Program, the CCP will initially provide an enriched 16-week research experience for up to 15 undergraduates per semester, an opportunity that is not typically available at undergraduate institutions. Extensive evaluation data have shown that student involvement in cutting-edge research and a positive mentor relationship are keys to favorably influencing undergraduate pursuit of graduate studies and future careers in basic research and advanced technologies. The CCP is designed to provide such an incentive.

The program places special emphasis on building Laboratory diversity (i.e., underrepresented minorities), recruiting and selecting women and underrepresented minorities. Program participants and their Laboratory mentors will work together on significant research problems while doing so at a relatively low cost to the Laboratory since technical staff are asked to volunteer their time while serving as mentors and tutors. Supplementary educational activities to complement the 16-week research appointment are designed to enrich the participants' technical backgrounds and broaden their perspectives for future career decisions. These activities, combined with individual scientific research guided by mentors, make the College Co-op Program a powerful opportunity for participating students.

## Performance Objectives and Milestones

The goal of the College Co-op Program is to develop a diverse work force of individuals with enhanced problem-solving and technical skills to meet the Laboratory's current and future scientific and technological needs, and to contribute to the research of technical line organizations.

The objectives that support this goal are to

- require that students contribute directly to ongoing Laboratory research projects;
- attract students to learn in Laboratory-identified Critical Skills areas;
- strengthen and focus students' fields of study and career plans;
- increase diversity of students that participate in national research programs;
- increase students' knowledge and skills in science, math, engineering, and computer science; and
- increase students' understanding of research process.

These objectives are formally and informally measured and evaluated through instruments and techniques that include surveys, informal feedback from mentors and students, observations, and assessment of student products. Assessment tools will be designed to provide coordinators and staff information to ensure quality undergraduate research experiences. These tools will include pre- and post-surveys, weekly student feedback sessions, site visits and observations, technical presentations, and a poster session display. The student products (presentation and poster display) will provide additional information to determine if students are increasing understanding of the research process and the research topic, and improving their

communication skills. In addition, students will be encouraged to submit results of their research for a journal for publication.

Indicators of success for CCP are

- Broad-based excellence in science and engineering
- Clearly defined roles and expectations
- Participating colleges with adequate infrastructure and support for co-op programs
- Adequately funded Laboratory infrastructure and coordination
- High-quality students, mentors, university faculty participation
- Clear connection to work force needs
- Student research that is important and engaging
- Educational component tied to university curricula
- Use of assessment data for continuous quality improvement

Supporting the Laboratory in fulfilling "Institutional Goal #7 – Focus on diverse, entry-level and strategic hiring" is the most important contribution of this program. CCP supports Laboratory needs with quality research now and in the future by building the diversity of the scientific candidate pool. Undergraduate students will work closely with scientific researchers in areas strategically related to the Laboratory mission and the needs of sponsoring technical line organizations. Research areas include projects from basic science through process engineering. Project areas include advanced computing, improved sensors, high-energy materials, enhanced surveillance and satellite research, and new technologies that support the Laboratory's scientific direction. In support of the stockpile stewardship mission, students will conduct research and contribute to basic science in areas such as analysis and assessment, theory, computer modeling of complex systems, environmental stewardship and technologies, and nuclear science. Los Alamos National Laboratory wishes to locate and retain quality staff for a variety of technical positions. The Co-op Program will assist in this effort to locate superior quality students.

The CCP student recruitment effort targets the best schools in science and engineering. Based on an initial assessment of top schools with co-op programs, the effort began with Texas A&M (1,064 co-op students), Georgia Tech (2,363 co-op students), and the University of Michigan (300 co-op students). New Mexico and California universities as well as Morehouse College will also be considered in the initial set of schools to contact in FY02. Selection of university partners will be defined with respect to strengths in scientific disciplines.

Students are recruited through a variety of strategies that include on-campus posters, a Web page, individual contacts at universities, student ambassadors (past participants), and recruiting visits by coordinators to targeted universities and colleges. Based on experience, we believe it is important to have a Laboratory technical staff member and a local university professor or administrator serve as champions for each university. It is preferred that the laboratory technical champion be an alumnus of the university he/she represents. The time necessary to make initial contacts, open lines of communication, establish champions, and formalize agreements is significant. Future success will depend upon ongoing recruitment and regular maintenance of university contacts.

The inaugural 16-week program began in September 2001 and will continue with a new group of students in January 2002. When applications are submitted, students will subsequently be selected and assigned a laboratory mentor. Internally, we will implement procedures for soliciting research proposals, reviewing the proposals, selecting the research projects and mentors, and strategically placing students.

The program is designed so the participants spend approximately 80% of their time

conducting science research with their mentors and 20% of their time participating in special supplementary educational activities designed to provide them with an introduction to research that supports the Laboratory mission. These activities include tours, field trips, lectures, workshops, technology training, and demonstrations. In addition, students are instructed in preparing and displaying a scientific poster session, giving a technical presentation, and writing a scientific paper. Special seminar sessions which highlight research skills help strengthen student understanding of the research process.

Formal partnership agreements with participating universities are in the process of being established. The agreements will include university commitments such as identifying top-quality students and participating faculty. Estimates from our hosting scientists indicate that, on average, a typical mentor scientist and hosting group will contribute over 100 hours of time per student per semester to support the research component of this program, and another 30 hours supporting the educational and tutor components. In addition, talks are presented throughout the semester that are prepared and delivered by scientists and staff who donate their time to enhance the experience of the students. There will be approximately 15 enhancement activities totaling approximately 60 hours of volunteer time.

## Highlights of this Year's Accomplishments

The highlight of this young program was the successful recruitment and placement of three highly qualified students for the inaugural Fall 2001 semester co-op phase. By all accounts the students enjoyed a rewarding experience and plan to return to the Laboratory for an internship in summer 2002. Clearances are being processed for the three in order to allow them access to a wider variety of research facilities upon their return.

Glenn Matthews (Fig. 22), a Georgia Institute of Technology student with a 4.0 GPA, majoring in materials engineering. His mentor was Dr. Cindy Sandoval of ESA-WMM (Weapons Materials and Manufacturing). His research project involved researching the production of ceramic particles using a plasma torch and performing adsorption experiments in an effort to understand the mass transfer of water and gases through foam materials. Glenn will be returning this summer to continue his research with Dr. Sandoval.

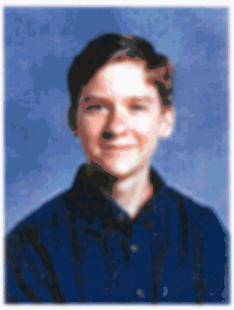


*Figure 22. Glenn Matthews.*

Nabil Schear (Fig. 23), a Georgia Institute of Technology student with a 3.6 GPA, majoring in computer science. Nabil's passion is in high-performance computing and intelligent systems. He was able to use these talents in NIS-9 (Weapons Technologies) under the tutelage of Dr. Keith Lindsay. His research was working with the Multi-Platform Trusted Copy (MPTC) software development team that is developing a cutting-edge cybersecurity application using Java. Nabil continues to work for Dr. Lindsay on an off-site basis during this semester and will return to the Laboratory in the summer.

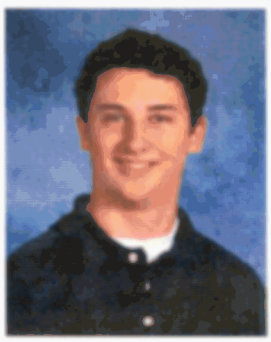


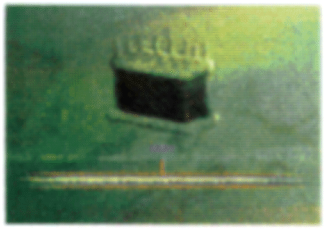
*Figure 23. Nabil Shear.*

David Seigel, a New Mexico State University student with a 4.0 GPA, majoring in mechanical engineering. David enjoys working with materials and was able to expand his knowledge with the help of his mentor, Dr. David Hayden at ESA-WMM (Weapons Materials and Manufacturing). His work included the adaptation of tooling and fixturing to new isosatic and die presses. David will be returning to the Laboratory this summer to continue his research project.

Recruitment is in full swing for the spring 2002 semester. One student has been identified and has accepted a co-op position at the time of this accounting:

Mark Pape, a Texas A&M University student with a 3.9 GPA, majoring in applied mathematical sciences. Mark's excellent proficiency in mathematics and computers will be enhanced with assistance from his mentor, Dr. Loren Toole at D-4 (Energy and Environmental Analysis).

Plans are in place to expand the College Co-op Program by Fall 2002 to reach the targeted 15 students per semester. However, all support for the program comes from the sponsoring technical organizations; therefore, further expansion of the program will be dependent on available FY02 programmatic funding.



# Fuel Cell Video Documentary

## Program Description

In May 1999, the Office of Advanced Automotive Technologies at the Office Transportation Technologies tasked the Fuel Cell Education Project at the Laboratory to develop and produce a video documentary on fuel cells. The title of the documentary will be *Fuel Cells – The Energy Revolution.* The goal of the documentary will be to inform a general audience about the benefits of fuel cell technology and show the exciting and diverse opportunities the technology holds for the future.

The scope of the documentary will be international. Viewers will learn about the work being done in the US, Europe, and Japan. Demonstration projects such as the Chicago Transit buses, Munich airport buses and refueling station, the Desert Research Institute sustainable energy system, the Iceland project to develop a hydrogen energy economy, and the London taxi will be included. Transportation, utility and portable power applications for fuel cells will be included.

The documentary is being produced at the Laboratory. Cambridge Documentary Films (CDF) serves as primary consultant on the project. CDF has been making films about social issues for more than 20 years. Their numerous achievements include an Academy Award; their films have been presented at film festivals around the world. Through their non-profit distribution company, their films have reached thousands of students and educators, community leaders, and concerned citizens.

The documentary will make the viewing public aware of the numerous applications and benefits of fuel cell technology. It is fair to say the automobile changed the industrial and social fabric of the United States and most countries around the globe. Henry Ford epitomized "Yankee ingenuity," and the Model T helped create the open road, new horizons, abundant and inexpensive gasoline...and tailpipe exhaust. More people are driving more cars in 2001 than ever before—more than 200 million vehicles are on the road in the US alone. But the car has contributed to our air and water pollution and forced us to rely on imported oil, helping to create a significant trade imbalance. Today many people think fuel cell technology will play a pivotal role in a new technological renaissance—just as the internal combustion engine vehicle revolutionized life at the beginning of the twentieth century. Such innovation would have a global environmental and economic impact.

The primary focus of the documentary will be fuel cells for transportation. Viewers will be shown that fuel cells are not just laboratory curiosities. While there is much work that needs to be done to optimize the fuel cell system (remember, the gasoline internal combustion engine is nearly 120 years old and still being improved), hydrogen fuel cell vehicles are on the road—*now*. The film will show commuters living in Chicago who ride on fuel cell buses as well as a fuel cell motor scooter about to make its debut in Taiwan.

In addition, the documentary will show that every major automobile manufacturer in the world is developing fuel cell vehicles. The introduction of fuel cells into the transportation sector will increase fuel efficiency, decrease foreign oil dependency, and become an important strategy/technology to mitigate emissions concerns.

Viewers will also learn about additional applications for fuel cells—including utility applications such as office buildings and homes as well as portable power requirements, which could include laptop computers and cellular phones.

## Performance Objectives and Milestones

During FY01, postproduction efforts began on the video. These activities began at the Laboratory, working with the Imaging Services (IM-4) Group. Editing began to select appropriate segments from interviews to be included in the video. Additional descriptive and historical footage was acquired. In December, Marcia Zalbowitz, producer/director of the video documentary, relocated to the Albany, New York area and postproduction activities were also relocated. At the suggestion of Cambridge Documentary Films, Context Media in Providence, Rhode Island, was selected to continue the postproduction work begun at the Laboratory. Work began in Rhode Island in January 2001.

## Highlights of This Year's Accomplishments

100% of the interviews and filming have been completed on the documentary. The following people will be included in the video:

- Mr. H. Watanabe, Board Member, Toyota
- Dr. Alan Lloyd, President, California Air Resources Board
- Prof. Joan Ogden, Princeton University
- Paul MacCready, President, Aerovironment
- John Wallace, Ford Motor Company
- Harry Pearce, former Vice Chairman, Board, General Motors
- Chicago Transit Authority Frank Kruesi
- Chris Galvin, CEO, Motorola
- Desert Research Institute
  Glenn Rambach Student
- Bill Poldony, Retired, International Fuel Cells
- William Miller, CEO, International Fuel Cells
- Georg Burkhardt and students (Germans teacher and students)
- Jon Bjorn Skulason, Iceland New Energy Project
- Don Huberts, CEO, Shell Hydrogen
- Shimshon Gottesfeld, CTO, MTI Micro Fuel Cells
- Christine Sloane, General Motors
- Andrew Brown, Jr., Delphi Automotive
- Tom Gross, Deputy Assistant Secretary, Office of Transportation Technologies, US Department of Energy
- Graham Batchelor, President, Alternative Fuels, Texaco

The project is in "rough cut" stage. Aside from the new opening, all the elements of the program have been completed.

A draft detailed distribution plan has been prepared for the Office of Advanced Automotive Technologies. Areas included in this plan are premiere, US distribution, international distribution, study guide, and computer-based and electronic distribution.

## Fuel Cell Tutorial

This work began in October 1999, when the 36 page, four-color publication, *Green Power – Fuel Cells* was published. This activity began in May 1998, when the Fuel Cell Education Project at the Laboratory received funding from the Office of Advanced Automotive Technologies (OAAT) at the Office of Transportation Technology at the US Department of Energy, to develop

of a tutorial for high school and college students on fuel cells. The 3M Foundation also supported this work through a financial contribution.

## Performance Objective and Milestones

An important objective has been to make the publication available to a wide audience by

- Developing a "standalone" publication containing detailed and up-to-date information on current developments in fuel cell research and technology
- Stimulating independent inquiry by providing appropriate follow-up resources
- Creating an engaging and visually attractive brochure

## Highlights of This Year's Accomplishments

The publication has gone to its 4th print; over 40,000 copies have been distributed worldwide. High school and college students from around the globe have requested copies. Thousands of copies have been requested by industry. Major automobile manufacturers, fuel cell companies, and suppliers are distributing the publication to their staff involved in the newly formed fuel cell research and development areas. The publication has been translated into Japanese, German, and Spanish.

## Tutorial Based Web Site Program Description and Accomplishments

*Fuel Cells - Green Power* is also available on the internet at http://education.lanl.gov/resources/fuelcells in PDF format for easy and convenient downloading. The site tracks approximately 7,500 hits per month. Hyperlinks to references and resources are included in the text. E-mail comes from around the world—from students as well as businesses. Our responses provide information, references and referrals. Technical experts occasionally assist in assuring complete, accurate answers.

## Graduate Automotive Technology Education Program Description and Accomplishments

Under the direction of the Office of Advanced Automotive Technologies (OAAT) at the Office of Transportation Technology, the fuel cell education program was tasked to edit and oversee the design and publication of a four-color brochure to introduce the Graduate Automotive Technology Education (GATE) program to college students throughout the country.

The GATE program was established by DOE to ensure that a trained work force will be available to continue development and commercialization of the OAAT research efforts. The goal of the GATE program is to educate a future work force of cross-disciplinary automotive engineering professionals who are knowledgeable about and experienced in developing and commercializing advanced automotive technologies in areas of

- Hybrid-electric vehicles and compact power electronics
- Advanced batteries
- Direct-injection diesel technologies
- Fuel cell and processing technologies
- Lightweight automotive materials

The brochure was designed to highlight the work currently being done in ten universities throughout the country. Each school has been designated as a GATE center through a competitive process. Information about the advanced automotive curriculum is included along with goals and objectives of each program. Biographies of the GATE students along with the GATE professor/coordinator at each school are also included.

# GEM Fellowship Program
# The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc.

## Program Description

The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM) Fellowship Program "is an ever-increasing business case educating and impacting the need for engineers and scientists at the graduate level. Companies, universities, and nonprofit organizations have long had a desire to solve the problem of underrepresentation, and it has been that desire that has built and sustained the GEM Consortium over the last 25 years, allowing GEM to award one of the most prestigious fellowships in the country (GEM's Strategic Plan: 2001–2003, p. 4)." Thus, the Laboratory benefits immensely and immeasurably through the success of the GEM Consortium for its current and future scientific work force. The Laboratory has sponsored up to 42 GEM Fellowships since becoming a corporate member in 1979. Membership with the GEM Consortium further affords the Laboratory access to all GEM Fellows to pursue for possible post-doctoral appointments or full-time research positions.

The GEM Website address is as follows:
http://www.nd.edu/~gem/

**Focus of the Program**
The intent of this corporate membership with the GEM Consortium is to establish a sustained and continued pipeline of graduate students in science and engineering into the Laboratory's research population and pursuits.

**Grade-Level Targeted**
The GEM Consortium is targeted to underrepresented graduate students throughout the nation who are pursuing master's and doctorate degrees in engineering and science.

Two former LANL GEM Fellows, Mr. Flores and Ms. Jones expressed their thoughts regarding how beneficial their summers at LANL were as they fulfilled the two consecutive summer internship requirements. And, two current GEM Fellows, Mr. Romero and Mr. Snyder, also expressed how important their fellowship is to their graduate and future and career goals.

Ms. Shaheerah Fateen worked in the Fuel Cell Laboratory of the Engineering Sciences and Applications Division, Applied Engineering Technologies Group (ESA-AET) in the summer of 2001. She is currently pursuing a master's degree in environmental engineering at the Massachusetts Institute of Technology (MIT). Shaheerah's presented research entitled, *Fuel Cell Systems for Personal and Portable Power Applications* involved examining the feasibility and trade-offs of using hydrogen polyelectrolyte membrane (PEM) fuel cells and direct methanol fuel cells (DMFC) to power portable electronic devices. However, currently Shaheerah's research at MIT has taken her to Brazil to conduct research on the design of a wastewater treatment system there.

As a GEM Fellow, Mr. E. Michael Flores published a paper entitled, *Numerical Modeling of Steady-State Heat Pipes with Axially Varying Heat Sources.* This paper was based on numerical work completed at the Energy Process Engineering Group of the Engineering Sciences and Applications (ESA) Division. He completed his master's at The University of Washington.

Michael was mentored by former Lawrence Livermore National Laboratory (LLNL) GEM Fellow, Donald L. Quintana, Ph.D., who further encouraged Michael to apply to the GEM Fellowship Program. Michael was hired into the Laboratory in May 2001 as a technical staff member (TSM) within the same group.

Ms. Triana N. Jones completed her master's at The University of Maryland-College Park. Triana stated, "The GEM Fellowship helped me to successfully achieve both my academic and career goals. My academic goals included attaining additional knowledge in the field of chemical engineering with an emphasis on bioremediation. I used that knowledge and research experience to present a paper at the 1999 Annual Convention of the American Institute of Chemical Engineers in Texas. Upon completion of my thesis, *Characterization of Anaerobic Polycyclic Aromatic Hydrocarbons Degrading Microbial Communities from the Baltimore Harbor*, preliminary findings will further aid in the successful cleaning of these contaminants form the sediment of the Northwest Branch of the Baltimore Harbor." Triana's mentor was David Cremers of the Chemical Science and Technology (CST) Division in which her summer research was completed and entitled, *Investigation of Calibration Methods for Soil Analysis Using Laser-Induced Breakdown Spectroscopy.*

One of our current Fellows, Mr. Russell S. Romero (Fig. 24), is in his first semester at the University of California-Berkeley, where he is studying mechanical engineering. While at the Laboratory, Russell performed research in two different groups to include the Materials Science & Technology (MST-8) and Environmental Sciences and Applications-Weapons Engineering (ESA-WE). Russell's research with MST-8 involved synthesizing bulk single crystals of erbium oxide, a material that was being studied as part of the stockpile stewardship program because of its resistance and inertness to extreme temperatures. Crystals were synthesized using a xenon optical float zone, which is capable of generating the temperatures needed to melt the erbium oxide for single crystal synthesis. Russell has published a number of articles from his research at the Laboratory, one being, *Mechanical Behavior of Erbium Oxide Single Crystals.* Russell's research at ESA-WE consisted of three different projects that allowed experience in engineering design, conceptual design, and experimental design. These projects are on going. Russell is expected to return to continue his work on them as they progress.

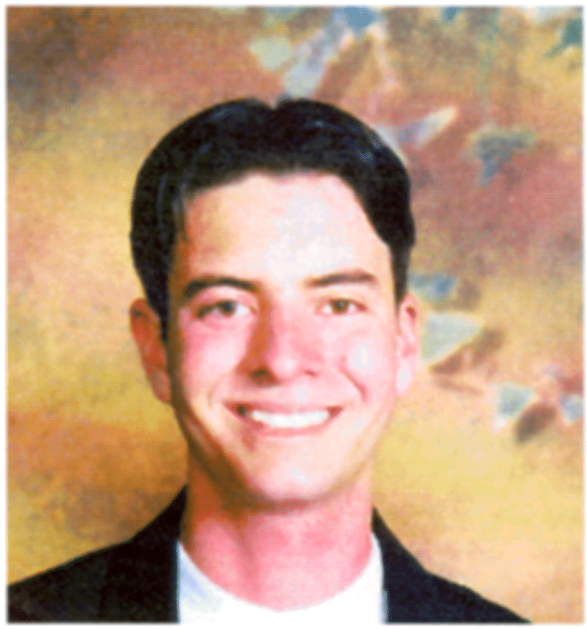


*Figure 24. Russell Romero, ESA-WE.*

Current GEM Fellow, Mr. Jimmie Snyder, Jr. is attending the Georgia Institute of Technology studying Civil Engineering. Jimmie's GEM Fellowship allowed him the opportunity to attend the graduate school of his choice while summers at the Laboratory afforded him the unique opportunity to interact and forge friendships with students from across the nation.

During Jimmie's three summers at the Laboratory, his research revolved around the construction of the Strategic Computing Complex (SCC). However, as Jimmie's research experience revolved around the SCC project, he had the opportunity to work in three different research areas of the Laboratory. In the summer of 1998, Jimmie worked with Doug Volkman assisting the

Facilities Engineering Group with the design and renovation of their existing parking structure, where he collected statistical data on traffic patterns and the design of a new parking area to accommodate employees displaced by SCC construction.

Jimmie's following two summers included working with mentor Mark Harris in the Project Management Division (PM). There, Jimmie assisted the PM Division with the development of satellite parking areas to assist employees displaced during construction of, again, the SCC. To accomplish this task, Jimmie was responsible for the procurement of excavation and burn permits, inspection of stormwater pollution controls, and contractor oversight on civil/structural activities. His final summer included assisting the PM Division in the design review, construction inspection and management associated with the Strategic Computing Complex project.

**Program Description/Design**

As a corporate member of the GEM Consortium, the Laboratory program is to provide funding for GEM Fellows to pursue master's and doctorate degrees in engineering and science. To successfully work with the GEM Consortium, the Laboratory not only provides graduate funding assistance, but summer research opportunities to its GEM Fellows. Consequently, to fulfill the requirements of the GEM Fellow agreement through GEM Headquarters, funded Fellows spend two consecutive summers at the Laboratory conducting research.

**Recruiting Strategy**

The recruitment strategy for the corporate membership/partnership with GEM Headquarters is primarily through educating students in the Laboratory's summer internship program of the merits and benefits a GEM Fellowship would provide to enhance their continued graduate education and their future career goals. However, additional recruitment while on campus visits and during career fairs is another avenue to encourage students to consider summer and/or academic year research opportunities. It is hoped that a GEM fellowship is a positive draw to consider the Laboratory as a viable future career option. Membership with GEM is an obvious indication of the Laboratory's commitment to human and research diversity.

Also, the Laboratory's GEM alumnae/alumni are instrumental in marketing our relationship/partnership for future Fellows. Currently, two alumni serve on the Laboratory's GEM Selection Committee, established in 2000 to ensure suitable and talented selection of the Laboratory's GEM Fellowship recipients. They are mentioned above, Donald Quintana, Ph.D., and Michael Flores. "GEM alumni and alumnae are a natural extension of the marketing effort in that they are the most credible advocates, having been GEM Fellows" (GEM's Strategic Plan: 2001–2003, p. 8).

## Performance Objective and Milestones

LANL is providing a stimulating research environment for aspiring young researchers through the GEM Consortium as their goal to "support and develop minority graduate students" is met.

This fiscal year resulted in the development of a Laboratory Selection Committee consisting of leadership from the LANL Employee Scholarship Board, two former LANL and LLNL GEM Fellows, a postdoc, and two staff members from the Education Program Office. One Committee goal is to build on the long-standing relationship to further increase the Laboratory's GEM Fellow numbers. That success will ultimately develop a continuous pipeline of qualified graduate students into the future ranks of advanced scientific research and management.

That Committee selected two new GEM Fellows:

| Degree | University | Major |
|---|---|---|
| Ph.D. | Stanford | Materials Sci./Eng |
| M.S. | MIT | Environmental Eng |

The above-mentioned goal would encourage current GEM Fellows and future applicants to pursue careers in technical areas with the goal of attracting selected students to the Laboratory as regular members of the technical staff or future partners in research, should their career paths find them teaching at the university level.

The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM) membership with the Laboratory is not DOE-funded.

# Hertz Foundation Scholars Program

## Program Description

Summer 2001 was the inception of the Hertz Foundation Scholars Program at the Laboratory. The program provides summer graduate research associate positions to Hertz Foundation Scholars who are working towards a Ph.D. degree in applications of the physical sciences ranging from electrical engineering to molecular biomedicine. The Laboratory recognizes these young men and women as having some of America's most promising technical talent and having received recognition from one of the most prestigious foundations in the nation. The average GPA of the group, which participated in the program this year, was 3.87.

Hertz Scholars are recruited from the list of finalists who are competing for the Hertz Foundation Graduate Fellowship award. To be eligible, a student's major must be in applied sciences (i.e., aeronautics, modern biology, computer science, material science, etc.). The Hertz Foundation only accepts applications from students who will be attending one of three-dozen prominent graduate schools (Table 12). Only about twenty-four students actually receive the "fellowship" award that consists of a cost-of-education allowance and a personal-support stipend. Los Alamos National Laboratory contacts all of the finalists to offer them summer research opportunities.

These graduate students work beside some of the Laboratory's best mentors. The contribution that these students bring to the Laboratory in such a short time is remarkable. As it is extremely important to the future of the Laboratory to attract the next generation of quality scientists and engineers, this is a partnership that has promising prospects.

## Schools Attended by FY01 Hertz Scholars Program Participants

When the Hertz Fellowship awards were announced in April, the Laboratory received copies of the Hertz applications of the finalists and the Fellows. The Science and Technology Base Education Program Office contacted each of these students to determine if they would be interested in a summer research position. Those who were attracted by the challenging research that Los Alamos National Laboratory has to offer responded to our invitation.

At this point a search for the best mentor and research experience was pursued. Some of these talented students actually had several research

**Table 12. Hertz Student Statistics**

| Undergraduate/Graduate School | Number of Students |
|---|---|
| Cornell University | 1 |
| Harvey Mudd College | 1 |
| United States Military Academy | 1 |
| University of California at Berkeley | 3 |
| University of Central Florida | 1 |
| University of Illinois at Urbana-Champaign | 3 |
| University of Tennessee at Knoxville | 1 |
| University of Texas at Austin | 1 |

**Table 13. Hertz Student Major and Specialization**

| Major | Specialization |
|---|---|
| Material Science and Engineering | |
| Civil Engineering | Structures |
| Physics | Astrophysics |
| Mechanical Engineering | Fluid Mechanics |
| Physics | Condensed Matter Physics |
| Materials Science | Transmission Electron Microscopy |
| Geological Sciences | Geochemistry |
| Chemistry | Synthetic Polymer Chemistry |
| Electrical Engineering | Communications/RF |
| Mechanical Engineering | Controls/Robotics |
| Bioengineering | Medical Imaging |

offers and were allowed to choose the option that best fit their studies (Table 13).

## Performance Objective and Milestones

The principal objective of the Hertz Foundation Scholars Program is to encourage some of our nation's finest graduate talent to share their expertise with the Laboratory and to provide these students a challenging and unique research opportunity, with the ultimate goal being to recruit them into the Laboratory work force. Participants will have access to facilities and state-of-the-art equipment at Los Alamos not ordinarily available on a university campus, as well as contact with many of the world's most illustrious scientists.

The enriched summer research sessions will enable the students to

- Increase their knowledge and skills in their fields of study
- Increase their understanding of the research process
- Increase their understanding of national laboratories and the important research being accomplished at these facilities
- Strengthen and focus their fields of study and career plans

Strategically, this program targets Los Alamos National Laboratory's *Institutional Goal #7*: "Focus on diverse, entry-level and strategic hiring." Diverse and entry-level students make up this program. Participants will be tracked throughout their graduate studies to ensure that Los Alamos National Laboratory will be a viable and challenging option when they are ready for postdoctoral appointments or permanent employment.

## Highlights of this Year's Accomplishments

The twelve participating Hertz Foundation scholars arrived from May through July and most were able to experience at least ninety days of research at the Laboratory. Besides the camaraderie they experienced by having adjacent rooms at their housing location, there were two social events.

**Luncheon Hosted by Dr. John Browne, Director of the Laboratory**
On July 11, 2001 Dr. John Browne hosted an informal luncheon to recognize the Hertz Foundation scholars. In addition to the Director and the scholars, those in attendance included the Deputy Director for Science and Technology, the Chair of the Hertz Foundation Board of Directors, and the Science and Technology Base

Education Program Office (STB-EPO) staff who were directly involved in recruiting and placing the students. The students were welcomed, and lunch was followed by an informative Q&A session led by the Director.

**Discussion/Recruiting Gathering**

On August 7, 2001 the students met at an STB employee's home to discuss each of their research experiences, mentor information, recruiting suggestions for the next group of Hertz scholars, etc. Follow-up and continuing contact with STB and each of his/her individual mentors was encouraged at this meeting. A report was compiled of the suggestions that were gathered (Table 14).

**Success Stories from the FY01 Program**

- One student's research project proved to be so successful that his mentor sent him to a conference in Edinburgh, Scotland, in December 2001.
- One student worked on a sensor prototype that has possible patent implications.
- Another student's summer research on computer simulations was submitted to a technical journal for publication.
- One student was honored to be the *only* first-year graduate student to present his work at a Nanomechanics Workshop where Los Alamos National Laboratory, Sandia National Laboratory, and Pacific Northwest Laboratory were represented, among others.
- One student's works was recognized as assisting national security; his work on a related subject involved assisting with national environmental concerns.
- One of the electrical engineering graduates was nominated for a Laboratory "Distinguished Student Performance Award."

## Mentor Comments

*"... is an outstanding student, and indeed would be ranked as outstanding if he were already a full-time laboratory staff member. In my 20 years at this laboratory, I have never seen a student with such a combination of technical understanding and mature program leadership."*

*"... interest in PGE has really helped to jump start our work in this area ($CO_2$ sequestering), which not only benefits the $CO_2$ project (a national problem in its own right), but also budding efforts related to PGE and national security. By having her here at the lab, we were able to recognize these other connections..."*

*"My Hertz fellow turned out to be the most productive summer student I have ever had...He*

**Table 14. Students' Suggestions for 2002**

| Housing | Social | Timing |
|---|---|---|
| Continue adjacent housing locations | Provide Hertz rental cars or a special low rate, especially for weekends | Earlier offer date needed |
| Provide at least one VCR, so they can share | Arrange an earlier first "social" gathering | Laboratory offers needed in late February or early March |
| Have stove and oven available (Housing was in LA Inn for 2001) | Provide a directory of services for local area | |
| Continue Hertz Foundation subsidized housing | Provide a bulletin board/ chat room for students | |

*has been exposed to the great variety of research going on at a national laboratory. He has commented that he is now considering such places as possible career choices. Before, he thought he would only consider academic careers."*

*"...Based on (his) work, we feel that we are extending the state of the art in structural health monitoring significantly beyond our competitors' research. As a further attest to the quality of (his) work, I plan to send him to a conference in Edinburgh, Scotland this December to present the work he has done this summer at a conference focused on Smart Structures Technology. The bottom line is that I want more ... to work with in the future. My only suggestion is that we find out earlier in the spring about the Hertz Fellow's availability."*

*"We hope that his experience at Los Alamos will encourage him to consider a National Lab Postdoctoral fellowship as one of the exciting options to consider upon completion of his graduate degree. Please consider me (as a mentor) for the program next year."*

*"I am quite impressed with .... He is very independent and well organized for someone not yet exposed to graduate level research. I highly recommend that other staff members consider mentoring a Hertz scholar in the future."*

*"... has worked very hard this summer and accomplished a lot. We are certainly looking at a journal publication or two based on the work he has done in the past two months. Since he is a first year graduate student at UC-Berkeley in Materials Science, he came to us with some general background in Materials Science. However, he had no hands-on experience in any of the research tools that we use. He was able to quickly learn physical vapor deposition, scanning electron microscopy...Rarely do we see summer students working so hard and achieving so much in such a short time. He certainly felt proud to be a Hertz Foundation student and that may be part of his motivation. I wish more such students were available to us at LANL. We are having an informal Nanomechanics workshop on August 20th at LANL and I have invited ... to present his work there. He is the only student presenting his work, all others are post-docs or staff scientists from LANL, SNL, PNNL, etc."*

*"...She has accomplished an amazing amount in a short period of time and I feel totally blessed to have had a student of her caliber fall into my lap. I would not hesitate to have another Hertz student... Clearly they really screen for the "best and brightest" in this program..."*

## Student Comments

*"My overall experience has been academically and scientifically fantastic."*

*"It's a great place to do science."*

*"The Lab is awesome."*

### First Year Suggested Improvements

For Summer 2002 research sessions we are requesting that STB-EPO receive a list of the finalists from the Hertz Foundation at the end of January 2002. By establishing the number of Hertz students who want to return and determining how many will be arriving for their first time research assignment here at the Laboratory (as early in the year as possible), we will be able to reserve apartments where they can share space and thus allow for more Hertz students to experience the opportunities that abound here at the Laboratory. Secondly, we are requesting that STB-EPO be allowed to make a formal presentation to the interviewees concerning the summer research experience at Los Alamos National Laboratory during the Hertz Foundation Board interviewing process.

### Hertz Foundation Scholars Program FY01 Summary

Los Alamos National Laboratory's collaboration with the Hertz Foundation was a tremendous success. This summer's Hertz experience was far

and above whatever we could have imagined! We plan to start the recruiting process at least two months earlier in 2002 in order to recruit a greater number of students. As the Hertz Foundation wants its Fellows to make a moral commitment to make their "skills available to the United States in times of national emergency..." what better way for them to contribute to the current status of national security.

# Los Alamos Space Science Outreach Program (LASSO)

## Program Description

The Los Alamos Space Science Outreach Program (LASSO) for FY01 is a collaborative ongoing effort between the technical community (NIS-1) and the educational community (STB/EPO) at Los Alamos National Laboratory. New Mexico contains a significant population of Hispanic and Native American people, traditionally underrepresented in scientific and technical vocations. LASSO contributed directly to LANL efforts to reach out effectively to this population. Focusing on current NASA projects exploring the composition of the solar system, the LASSO project realistically affected the educational community of rural New Mexico and the nation as a whole by enhancing science content knowledge, providing current science curricula, and decreasing isolation factors for teachers in rural areas. The program provides current science curricula and decreases isolation factors for teachers in rural areas through the World Wide Web (http://set.lanl.gov/programs/lasso/) and electronic communication models.

The LASSO project engages professional learners in sustained classroom activities directly tied to the NASA-LANL space science programs thus supporting improved science, math and technology content knowledge as well as life-long learning process skills. The LASSO science education effort adheres to an effective instructional model based on education research and cognitive theory. Through this program students and teachers engage in activities that encourage critical thinking, a constructivist approach to learning, research, reflection, cycles of inquiry, and iterative assessments over the life of a project.

The educational component of this project involves master teachers representing secondary and elementary school levels in the development of multidisciplinary/multilevel classroom lessons and activities that focused on the NASA projects through a collaborative, distance learning process. The master teachers enhance their use of computer technology through the development of skills in Web page creation, concept mapping, and Internet research. The teachers interact with LANL mentors throughout the program.

During the program, teachers critically investigate the LASSO projects through the examination of basic and advanced science concepts behind the project goals. LANL mentors from NIS-1 collaborate with the master teachers providing current science content, motivation and support. The master teachers learn how scientific data is collected, analyzed and interpreted. They learn effective instructional methods that are incorporated into effective Web-based lessons and activities published on the LASSO educational Website.

The master teachers continue collaborative efforts through telecommunications during the research and development phase. They participate in a culminating activity where they finalize and deliver their Web-formatted lessons and activities for the LASSO Website. Their final products were delivered at the end of the final summer session and the developed Web-based lessons are added to the LASSO Website.

## Goals

The LASSO program leverages Los Alamos National Laboratory's scientific capabilities and

resources by integrating current research in the area of space physics. The LASSO project supported the NASA education mission by aligning with the following:

- To increase public understanding of the issues relating to the future of space exploration.
- To develop the connections between scientific concepts and everyday life.
- To increase understanding of the science process.
- To provide opportunities to develop and apply critical thinking and problem-solving skills on complex problems of scientific significance.
- To promote cooperative learning through successful teamwork.

## Project Objectives

The LASSO project was designed to enhance the overall quality, scope, and realism of science, mathematics, and technology education in New Mexico schools by

- Increasing teachers' and students' knowledge of the science, math and technology involved in space physics;
- Enhancing teachers' skills in teaching the content of earth and space sciences, and the new exciting technologies;
- Providing hands-on activities and materials to utilize in the schools;
- Exposing teachers and students to the application of earth and space science to current and future research projects at national laboratories;
- Providing a mechanism for teachers to encourage students to pursue careers in earth and space science.

## Implementation Strategy

A select team of 20 master teachers, representing secondary and elementary school levels in northern New Mexico and west Texas were selected to participate in workshops held at Los Alamos National Laboratory. The master teachers worked together with Laboratory scientists to develop appropriate curricula for their educational communities. Scientists participated in the workshops by identifying basic concepts of space and planetary sciences while introducing new technologies behind current and future explorations. The teachers developed and implemented appropriate activities in their classrooms. The teacher-developed, scientist-directed, student-oriented units were inquiry-driven and modeled sound pedagogical practices. These practices included the constructivist learning theory, cooperative and collaborative learning relationships, and the integration of mathematics, science, and technology content. The teacher-prepared material was published on the LASSO Website thus impacting a wider community.

## Program quality was assured in the following ways:

### Workshops

The LASSO program was designed to match Laboratory expertise with the needs of schools in New Mexico to provide a unique educational opportunity tied to the NASA mission. Los Alamos National Laboratory program staff met with teachers in a series of workshops to develop and promote an effective curricular approach. The workshops demonstrated provisions of instruction for teachers in process and content, and the application of resources that required the teachers to sharpen their critical thinking and problem solving skills on current real space science projects.

Teachers were required to demonstrate their learning and understanding through various tasks that combined content information, research, critical thinking, problem-solving and telecommunications skills.

### Products

Each teacher was part of a team that produced dissemination products based on his/her work on the project areas. The teachers examined specific projects as conducted by the NIS-1 group, and worked to develop educational products. These educational products included grade-level specific lessons and activities. Products were produced for the elementary, middle school, and high school levels. Examples from the new lessons and activities include "Solar Detectives," "No Picture," "No Sound," "Space Science Web Quest," "Satellite," "Solar Folklore," "Changing Flavors: Unravelling the Mystery of Solar Neutrinos." Others are listed on the LASSO Website and can be accessed at http://set.lanl.gov/programs/lasso/standards.html.

## Demographics

Table 15 represents the breakdown of the participants by gender, ethnicity, location, population served, and academic level taught.

**Table 15. LASSO Demographics**

| **Gender Breakdown:** | | | |
|---|---|---|---|
| Total male participants | | 6 | 30% |
| Total female participants | | 14 | 70% |
| | **Total** | 9 | 100% |
| **Ethnicity Breakdown:** | | | |
| Total Caucasian | | 12 | 60% |
| Total minority | | 8 | 40% |
| | Total Hispanic | 7 | 35% |
| | | | |
| **Location Breakdown:** | **Population served** | **Level** | |
| Bernalillo | Hispanic and Anglo | Elem., Secondary | |
| Rio Rancho | Native American, Hispanic, and Anglo | Secondary | |
| Tucumcari | Hispanic and Anglo | Secondary | |
| Los Alamos | Anglo, Asian, and Hispanic | Elem., Secondary | |
| Mora | Hispanic and Native American | Elem. | |
| Mescalero | Native American | Elem. | |
| Los Lunas | Anglo and Hispanic | Elem. | |
| Floyd | Anglo and Hispanic | Secondary | |
| El Paso | Anglo and Hispanic | Secondary | |
| Santa Fe | Anglo and Hispanic | Elem. | |
| Newcomb | Anglo, Hispanic, and Native American | Secondary | |
| Crownpoint | Native American | Secondary | |
| Lovington | Anglo and Hispanic | Elem. | |
| Las Cruces | Anglo and Hispanic | Secondary | |

**Table 16. LASSO Milestones**

| LASSO Milestones | | |
|---|---|---|
| March 2001 | Recruiting FY01 cohort | Active recruiting ongoing |
| July 2001 | Workshop #1 – Science Content | Conducted July 9–12, 2001 |
| July 2001 | Workshop #2 – Pedagogical Content | Conducted July 16–19, 2001 |
| August 2001 | Workshop #3 – Wrap-up | Conducted August 6–9, 2001 |
| August 2001–April 2002 | Program implementation and report follow-up | Current implementation stage |

## Evaluation

Evaluation was composed of a combination of formative and summative strategies. A variety of evaluation tools were used to measure how well the program met its objectives. These evaluation tools included process feedback forms and teacher surveys. Follow-up activities are conducted throughout the academic year as teachers implement a variety of LASSO lessons. Teachers are expected to evaluate their implementation through evaluation of student papers, student presentations, and student-prepared products. The teachers submit final reports during the spring semester.

Review of the teacher surveys showed that the project was successful in meeting its overall goals. The teachers enjoyed interacting with each other during the LASSO workshops while conducting their research and completing their LASSO lessons and activities. Teachers generally agreed that the students learned a lot about the topics.

Evaluation of the program using a variety of tools and methods revealed that students and teachers demonstrated positive increases in the following areas:

- Understanding of space physics
- Content understanding in the monitoring of space phenomena
- Understanding of telecommunications
- Use of technology for research purposes
- Ability to use the computer to communicate and share information with others
- Ability to research a complex issue
- Use of concept mapping
- Understanding of content by using a problem-based approach to learning science
- Small-group work

## Program Highlights

The first workshop (Table 16) was held the week of July 9, 2001, at Los Alamos National Laboratory for twenty master teachers to begin developing classroom lessons and activities that support the LASSO curriculum efforts in the area of space physics. Teachers were immersed in the varying NIS-1 projects included in the LASSO effort. Project scientists discussed some of the basics included within their research. Seminars included lectures and demonstrations on particle physics, charged particles, and electromagnetic fields. Further studies acted as a background for advanced sessions on the solar wind and Earth's magnetosphere.

The second workshop was held the week of July 16, 2001, at Los Alamos National Laboratory. Twenty master teachers representing 14 NM school districts and 18 individual schools participated in the summer institute. The teachers engaged in the development of curriculum as well as establishing a communication network that would be utilized in the program to share

and disseminate curriculum ideas, thus reducing their isolation from the rest of the educational community. Los Alamos National Laboratory scientists participated as content mentors and offered a varied cross section of opinions and experiences within the space physics arena.

The final workshop was held the week of August 6, 2001, at Los Alamos National Laboratory. There were 18 schools, 20 teachers participating with 4 high schools, 4 middle schools, and 10 elementary schools represented. The projected overall student enrollment supervised by the twenty teachers was approximately 1200.

The master teachers used the Los Alamos National Laboratory Critical Thinking Curriculum Model (CTCM) and the Web Quest curriculum model developed at San Diego State University. The CTCM is a multidisciplinary approach to learning, encompassing computer technology, current real-world issues, and proven learning and teaching practices. This model features open-ended and collaborative activities and is designed as a project-based research experience for students and teachers to develop a conceptually correct understanding of the topic being studied.

Teachers became very comfortable using technology in the classroom, and it was expected that their students use the technology as part of their class.

## Teacher Comments

*"The LASSO program has helped me do my duties as a teacher in the computer age more effectively. The program has given me the ability to take my class to the next level as far as using the available technology. The Internet has become a useful educational tool in my classroom instead of a just a "toy" for the students to use as a reward. The workshop gave me the knowledge and experience I needed to make a true educational web site where students are asked to do and learn instead of just look or read. The workshop afforded me the opportunity to collaborate with other science teachers. I learned from what they are doing or have done in their classes."*

*"The LASSO program that I participated in the summer of 2000 was a great benefit to myself as well as my students. I benefited as a teacher and as a person interested in science. My students gained an appreciation for space science and self esteem."*

*"The LASSO workshop I attended in the summer of 2001 was a tremendous benefit to my knowledge base. My first teaching field is in biology. My knowledge of space science was limited at best. I teach at a small rural school that only has one science position. Because of this I teach all the high school science courses at our school. The LASSO program has given me the opportunity to expand my knowledge of space science in a way that no college course could do. I learned about what was happening on the cutting edge of technology and about programs that were only months or years old instead of decades. I was exposed to the knowledge and experience of scientists that are involved in one of the top space science programs in the world. No college class could compete with what I learned at the workshop."*

*The real benefit of the LASSO program was to my students. I named my project the Magnetosphere Project. The students were from my 9th grade physical science class. The class consisted of 20 ninth grade students. The learning curve was expediential. The first day of the project I asked the class how many had heard of the magnetosphere. The response surprised me. Not one student had even heard of the magnetosphere. The students did have some background knowledge of astronomy but knew very little about space science and any programs that involved the study of our solar system. By the end of the five-week unit the students were "magnetosphere experts." They could explain*

*the characteristics of the magnetosphere as well as how it and why it is studied."*

*"The project had a great effect on my students in the area of self-esteem. One of the greatest outcomes of the magnetosphere project is that the students know they learning about something that very few people in the world have any understanding about. This gives the students a sense of pride and builds their self-esteem. The students built models of the satellites and the magnetosphere. They were able to explain how the magnetosphere affects all areas of society. They also realized how much technology we use in our everyday lives is a direct and indirect result of the study of space science."*

*"The LASSO program at LANL is a much-needed resource to all science teachers. I am so busy with teaching that I have little time to research what is going on in the science world. The program puts me in touch with real scientists. I could never learn what I did attending the LASSO workshop in a college classroom. The students are the real winners. They get to learn about science that is happening today, not ten years ago. They learn about ideas and programs that affect them today and will affect them in the future. They have the opportunity to learn about something that most people have not even heard of. This builds on their self-esteem and pride. I think in the long run the LASSO program will have an effect on how students view science, the space programs, and themselves."*

# mathematicas y ciencias MATHAND Northern New Mexico Math and Science Academy

## Program Description

The Northern New Mexico Council on Excellence in Education (NNMCEE) developed the Math and Science Academy (MSA) with support from local school districts (Chama, Española, and Mora), the Northern Network for Rural Education, the University of California and the Department of Energy's Los Alamos National Laboratory. In the initial year of implementation, MSA's goal was to significantly improve math and science education, as part of a larger systematic change initiative to improve education for the students of Northern New Mexico. The project aimed to provide middle school teachers and their students the opportunity to work with exemplary science and math mentors and gain content knowledge, experience, and expertise by working collaboratively with a cadre of other committed schools and teachers.

The MSA project addressed multiple purposes, including providing teachers with access to rich professional development sessions to increase content and pedagogical knowledge; stimulating teachers to consider how well their instruction is preparing students for high school academics and how it can better do so; providing tools and conceptual structures for content area instruction that can be integrated directly into classroom teaching and learning practices; and providing students with opportunities to engage in higher quality science, math, social studies and language arts learning experiences. Initially, MSA targeted middle school students, in an effort to stem the high drop-out rate in 9th grade (8.1% in 1997, higher for Latino males), and to allow teachers adequate time to help their students develop the knowledge, interest, and enthusiasm to enroll in challenging high school classes. Finally, the first year of the project aimed to improve the overall quality of education in middle schools in Northern New Mexico, by providing opportunities for all students to engage in high-quality learning experiences taught by qualified, knowledgeable instructors.

Student test scores and teacher competency surveys reveal a tremendous need for improving student achievement and teacher preparation in northern New Mexico. MSA is, therefore, designed to (1) utilize master teachers and research-based best practices to significantly improve math, science, and technology education; (2) initiate systemic reform in northern New Mexico schools and colleges; (3) increase the pool of qualified teachers (Table 17); and (4) serve as a national model for improving mathematics, science, and technology education in rural communities. Development of the academy is viewed by northern New Mexicans as a very positive and necessary "good neighbor" initiative with the Laboratory. School districts were invited to apply for participation in the Math and Science Academy in late spring of 2000, and three schools (Figs. 25–27) were selected according to criteria developed by NNMCEE. The selected schools—Chama Middle School, Mora Middle School, and Española Middle School East—participated in the program during school year 2000–2001. The four core area (language arts, math, science, and social studies) teachers from each site—twelve teachers in all—took part in

**Table 17. 2000–2001 MSA Teacher Demographic Information**

| *Variable* | *Descriptor* | *n=12* |
|---|---|---|
| Sex | Male | 3 |
| | Female | 9 |
| Ethnicity | White | 2 |
| | Hispanic/Latino | 10 |
| | Native American | 0 |
| Highest Degree Received | Bachelor's + Credential + units | 5 |
| | Master's | 2 |
| | Master's + Units Beyond | 5 |
| Teaching Credential* | General Elementary | 6 |
| | General Secondary | 4 |
| | Special Emergency | 0 |
| | Multiple Subject | 5 |
| | Single Subject | 3 |
| | Bilingual | 3 |
| | Other: (K12, Spanish, Early Childhood) | 3 |
| Years of Experience | Average Number: | 13 years |
| | Range | 3–28 years |
| Previous participation in projects like MSA | Yes | 5 |

*Figure 25. Students from Chama Middle School.*

training during the summer of 2000 and at the follow-up sessions during the year.

During the 2001–2002 school year the program expanded to include all the 7th grade teams at the Española Middle School East and one 8th grade team at Española Middle School West, who are teaching the students taught last school year by MSA teachers. Twenty-two teachers are participating in the program this year, an increase of ten over the previous year. New components to the program this school year include three student teachers and a summer leadership institute for principals and district administrators of the participating schools. The bulk of the professional development occurs during an intensive summer institute focused on standards-based learning; assessments, including rubrics and portfolios; instructional strategies, including cooperative learning and integrating technology into the curriculum; and curriculum alignment. This school year there was an additional leadership institute for the principals and administrators from the three

*Fig. 26. Students from Mora Middle School.*

*Figure 27. Students from Española Middle School, East.*

participating districts to initiate the systemic change necessary for the success of the program. Another new aspect of the program this year is the student teacher component. Each site will have a student teacher for the spring semester to begin work towards one of the goals of MSA—to increase the pool of qualified teachers. The three selected student teachers participated in the summer training institute along with other new and returning teachers.

Many studies including the Glenn Commission Report, "Before It's Too Late," emphasize the importance of teacher quality on student achievement. The focus of the MSA program is to improve teacher quality by delivering professional development based on the latest research and by providing follow-up support in the classroom. Two master teachers form one of the core components of the MSA. One master teacher, Carol Brown, has been with MSA since its inception. The other, Catherine Berryhill, joined MSA in June 2001, filling the position vacated by Patricia Alvarado, who left the program in March of 2001. These master teachers are using their expertise in content, pedagogy, and reform initiatives to design and deliver most of the professional development and to follow up on site. During the 2000–2001 school year, master teachers visited sites once a week. The design has been modified based on input from participating teachers, and this school year, master teachers make extended visits to the outlying sites: Chama and Mora. There is a three-day visit and a one-day visit to each site each month.

The initial grade levels targeted are those in the middle schools of the respective schools: grades 6–8 in Chama and Mora, and grades 7–8 in Española. Last school year teachers worked with 7th grade students. This year the teachers in Chama Middle School and Mora Middle School are using MSA strategies with all the grade levels that they teach (6th–8th), and the program has expanded in Española to include all the 7th grade teams and one 8th grade team (following last year's 7th graders.)

The National Staff Development Council states in their standards that staff development that improves the learning of all students

- Organizes adults into learning communities whose goals are aligned with those of the school/district,
- Requires skillful school/district leaders to guide continuous instructional improvement, and
- Requires resources to support adult learning and collaboration.

It also says that staff development should deepen educators' content knowledge, provide them with research-based instructional strategies to assist students in meeting rigorous academic standards, and prepare them to use various types of classroom assessments appropriately. Staff development should provide educators the knowledge and skills to involve families and other stakeholders appropriately. It should also be data-driven, research-based, and have multiple sources of information for evaluating the program. (Full text at http://www.nsdc.org/educatorindex.htm) MSA is designed to provide training for teachers that is aligned to these standards.

The summer institutes (Fig. 28) are followed by classroom observations using the cognitive coaching protocol. This protocol involves a pre- and post-conference around a formal observation session. The questioning technique employed in the conferences promotes teacher self-reflection

and focuses on student learning. The nonevaluative nature of the protocol encourages teacher self-evaluation and thus accomplishes change from the bottom up. (The protocol is included at the end of this report.) Studies by Joyce and Showers show that even when teachers receive high-quality training, classroom implementation remains at about 5%. When professional development includes time for practice and feedback and the curriculum is adapted for the innovation, the percentage increases. However, implementation increases to 90% when professional development includes coaching in the design.

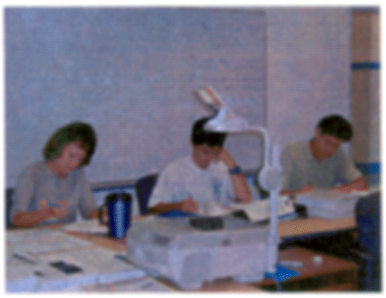


*Figure 28. New teachers work diligently during the 2001 summer.*

Teacher progress portfolios are a new dimension to MSA this year. Studies have shown that creating a portfolio will help teachers to focus on how they are incorporating what they learned during the summer institute into their practice. Teachers meet after school on a weekly basis to continue discussing standards, curriculum, assessments, and instruction. At Mora (Fig. 29) and Chama these weekly meetings are the only common planning time they have, while in Española each team has a daily common prep. Thus, in Española the after-school meetings are being held by content area, and a school-wide meeting is held once a month. Teachers use their common prep time once a week to discuss team issues. This time for dialogue between teachers is a critical part of the design of the program. The intent is to develop a culture at the schools where discussion and sharing about best practices, sound pedagogy, and student welfare is the norm and is built into the instructional day.

*Figure 29. Teachers meet after school in Mora.*

## Performance Objective and Milestones

The initial performance objective for MSA is sustained change in teacher practice that supports standards-based education. The ultimate objective is documented increase in student achievement in math, science, and technology application.

Standards-based education is a national movement that was initiated by the report "A Nation at Risk," by the National Commission on Excellence in Education in 1983. Today, all but one state has some form of standards in place. In New Mexico the State Department of Education has put into regulation content standards and benchmarks in nine content areas. Standards-based education, however, is more than content standards; defining content standards (what all students should know and be able to do) is only the first step. Standards-based education sets the goal for all educators to ensure that all students meet standards. No longer can teachers teach the subject, assess the learning, assign grades, and then move on. Teachers are given the mandate to ensure students have certain knowledge and skills in the content areas. Now it is imperative for teachers first to know and be able to define what it is they want students to learn (what students must know and be able to do.) Then they must design assessments that will inform them whether students have indeed met these standards. Finally, they must design the activities that will allow students to create the learning so that students are able to perform successfully on those assessments.

Assessment that is meaningful to the students as well as the teachers becomes a very important part of the teachers' practice. Once teachers develop the assessments that will let them know if students are meeting standards, they then must plan the instruction—all the teaching and learning activities—that will help the students perform competently on the assessments. Students must not only have a clear idea of the learning goals, they must also have a clear idea of what exemplary work/performance looks like. The target should not be a mystery. Well-designed rubrics and samples of exemplary work help everyone know what the target is. Everyone: teachers, students, parents, administration should know when a student has met a standard.

What happens when a student does not meet a standard? After a teacher has planned for the unit and a student has participated in the instruction and assessments, what does a teacher do if a student just cannot meet the standard? Standards-based education helps the teacher to reflect on his/her practice. Where can the remediation take place? Is it in the design of the assignments/activities? Is the stumbling block in the design of the assessment? Does the student just need more time and more ways to meet the standard? Who will work with these students, and when will extended remediation take place? These are questions that need to be addressed by teachers and administrators who are committed to standards-based education.

The types of changes in teacher practices being targeted in MSA include how assessments are changing to reflect standards, how instruction is changing to become more student-centered, and how curriculum is being refined to align to standards. For these changes to occur, professional development must include introduction to best practices, time for teacher collaboration, and time for teacher reflection.

Teachers currently in the program have classroom experience ranging from zero to 28 years. Teachers are at different points in their journeys as educators, and they are traveling at different speeds. It is difficult to apply a standard instrument to measure their progress towards standards-based education, especially since it is so multifaceted. Teachers have been asked to focus on one or two parts to study in-depth this school year. They are addressing these areas in their progress portfolios. They are collecting their work related to the areas as well as samples of the student work that is produced, and they will be reflecting on what they discover. Master teachers are using the cognitive coaching protocol to help teachers reflect on their practices, focus on student learning, and thus chart the progress of the teachers throughout the year.

The goals of the Math and Science Academy align with the institutional goal to refocus the Laboratory hiring on entry-level and strategic hires, with a simultaneous emphasis on diversity in all forms (diversity of people, fields, and technical ideas.) In order to increase the size of an educated and trainable work force, the schools in northern New Mexico need to provide focused and effective education to the students. Skilled and dedicated teachers are the key to increasing not only math and science achievement, but to increasing the number of students who are proficient in communication, problem solving, and learning what it takes to succeed in the future. Students who are thus prepared will be more likely to go to college and be successful. In areas like northern New Mexico, these successful students are more likely to return to their communities and look for work in the local area. One of the goals of the MSA is to ultimately increase this pool of qualified applicants for positions at the Laboratory. There have been some positive changes in teacher practice since the 2000 MSA summer institute. According to external evaluators from the National Center for Research on Evaluation, Standards, and Student Testing (CRESST) at the University of California, Los Angeles,

> "Survey results, observations and interviews of the twelve MSA teachers

indicate that the project influenced teachers in a number of ways. Specifically, MSA had an impact on teachers' (1) collaboration, planning and articulation (Table 18); (2) knowledge and familiarity of current research on teaching and learning, including grouping practices; (3) types of assignments, activities and assessments used; and (4) understanding of content area standards and standards-based instruction. These areas of impact were observed and reported to varying degrees at individual sites and for individual teachers in the project. Teachers reported the greatest amount of MSA impact on their willingness and interest in collaborating and planning with their colleagues. This finding was substantiated in our observations of teachers at their sites. As the school year progressed, we heard teachers more frequently engaged in formal and informal conversations about teaching, learning and MSA."

The evaluators added that

> "Collaborating with colleagues in meaningful ways meant that teachers discussed student work and instructional needs rather than focusing on the more negative aspects of school life, such as student behavior, administrative issues and the like. Further, teachers reported a higher degree of articulation and alignment of performance and behavior standards for students at their school sites as a result of these ongoing conversations."

The report also notes that on survey results teachers report only a moderate change in their approaches to guiding and facilitating student learning based on MSA work. The evaluators note,

> "... this was an experienced group of teachers, with well-established teaching preferences and patterns. As such, there was some reluctance initially to try different instructional approaches, including cooperative learning groups, group projects and more student-centered assignments. As the school year progressed, a willingness to try new approaches and ideas was endorsed quickly by some MSA teachers and more slowly by others."

As a response to another survey question, many teachers reported that MSA had an impact on the types of assignments and activities they utilized in their classrooms. The evaluators noted,

> "Work during the summer institute and follow-up sessions with project mentors

**Table 18. MSA Teacher Collaboration, Planning, and Articulation**

| *To what extent do you agree with the following statements:* | Mean (SD) |
|---|---|
| I develop yearlong and short-term goals for my students. | 4.2 (0.3) |
| I select content and adapt and design curricula to meet the particular interests, knowledge, skills and experiences of my students. | 4.3 (0.2) |
| I use strategies that develop student understanding and nurture a community of learners. | 4.1 (0.2) |
| I work with my colleagues within and across and disciplines. | 4.4 (0.2) |

highlighted the importance of providing a wide variety of learning settings and opportunities for students, in particular to provide learning settings in which students were involved with generative learning experiences. Teachers also were encouraged to experiment with project-based approaches to teaching and learning."

The teachers' assessment practices also began to focus more on student learning. Teachers reported (Tables 19 and 20) that they

> "began to understand that their "old" or traditional methods of assessing student learning were limited in the kinds of information about student learning that could be gleaned from these tasks."

One teacher commented,

> "I have learned to ask myself why I'm teaching what I'm teaching and get more relevant information out of the assessments I use with/for my students."

In the area of standards-based instruction, teachers are developing fluency with the terminology and the instructional sequence outlined in the content standards. They are also making the connection between what they teach and assess with the standards. On the survey teachers said that MSA was moderately effective in familiarizing them with standards-based instruction and content standards and benchmarks, in helping to develop interdisciplinary units, and in sharing assessment strategies.

The evaluators studied the results from the Comprehensive Test of Basic Skills (CTBS) Terra Nova Plus norm-referenced standardized tests that were administered to students at all three sites. They found no significant increase in scores or only a minimal increase of student test scores in all subject areas. They did add,

> "A number of caveats about the validity of using standardized tests as a measure of program impact should be mentioned. First, MSA is a new project and as such, it will take time to see the results in test scores. Second, standardized tests have come under criticism for not being generally sensitive to instructional changes nor are they well aligned with what teachers are teaching and the standards to which teachers and schools are being held accountable. Finally, quality implementation of project goals requires complete teacher buy-in and time to learn new techniques and incorporate them effectively into the teaching and learning process. High-quality implementation of

**Table 19. Guiding and Facilitating Learning**

| *Please answer the following statements based on your participation in MSA.* | Mean (SD) |
|---|---|
| I focus and support inquiry as I interact with my students. | 4.1 (0.2) |
| I orchestrate discourse among students about ideas. | 3.7 (0.2) |
| I challenge students to take responsibility for their learning and to work collaboratively. | 4.4 (0.1) |
| I recognize and respond to student diversity and encourage all students to participate fully in learning. | 4.8 (0.1) |
| I encourage and model the skills of inquiry as well as curiosity, openness to new ideas, and skepticism that characterize continuous learning. | 4.5 (0.1) |

**Table 20. MSA Effectiveness**

| *How effective was MSA in the following areas* | Mean (SD) |
|---|---|
| Familiarizing you with standards-based instruction | 3.9 (0.3) |
| Developing your knowledge of state frameworks for content areas | 3.9 (0.3) |
| Helping you develop interdisciplinary curriculum units | 3.9 (0.3) |
| Providing demonstration lessons that were meaningful and relevant to you and your students | 3.7 (0.3) |
| Sharing assessment strategies | 3.8 (0.3) |
| Informing/involving the community about MSA goals and objectives | 3.5 (0.9) |

*Note: Scale-1=Not effective; 3=Somewhat Effective; 5=Highly Effective*

new strategies is required before significant changes in student learning can be expected, in particular on a general measure of student achievement, such as a standardized test.

## Highlights of This Year's Accomplishments

During October 2000–May 2001, master teachers visited school sites approximately once a week. While in the classrooms, they interacted with the students, team taught with the classroom teachers, and occasionally demonstrated lessons. They also substituted in classrooms to allow a teacher to observe other MSA teachers. Master teachers met with the participating teachers at each site after school for two hours. During those sessions, teachers discussed issues surrounding students, the implementation of the integrated unit that was designed during the 2000 summer institute, lesson plans, and during the spring, some professional development on cooperative learning was accomplished. Master teachers also gave presentations to school boards and to personnel at district offices to familiarize them with MSA and its objectives. Additionally, teachers from all sites met four times during the school year for Saturday sessions to further extend their understandings of new ideas presented in the project and to collaborate with teachers at the other MSA sites. Master teachers, teachers, and students also gave MSA evening presentations for parents and community members.

One of the highlights was the field trip to Santa Barbara Canyon that students from Mora and Española enjoyed. Students traveled in small groups with a parent volunteer to five different stations where they had experiences in bird watching, a soil investigation, a nature walk, a written reflection, and a macroinvertebrate study. It was an example of collaboration between several entities to bring a rewarding experience to the students. La Jicarita Enterprises provided funding for the buses for this trip. Jaime Brytowski from the NM Department of Game and Fish designed one of the stations where students collected and observed macro-invertebrates. Donna House, a naturalist, volunteered her time to lead a nature walk. Judy Chaddick, the science specialist from the Española district, led the bird watching for the Española students and allowed us to borrow all her equipment for the Mora students. Linda Alane, the language arts teacher from Española, designed the reflection activity. Paige Prescott designed the soil

investigation. Parent volunteers acted as group leaders. Everyone involved with the event learned something new and had a very wonderful time.

Another highlight, especially for the students in Mora, was the dissection. Frog dissections in 7th grade had not taken place for many years, so the 7th graders were the envy of the school, and even the talk of the town. Collaboration among the teachers in Mora allowed each of the two 7th grade classes to spend three consecutive class periods dissecting their frogs. Science master teacher Carol Brown facilitated the experience for the students and also for the teacher, who had never dissected a frog before. This was the culminating activity at all three sites for the integrated unit titled "Who Am I?" during which the students had studied body systems in science. The learning goal was to understand the relationships between and the interrelatedness of the systems and to see the spatial arrangements of the different organs. The following are content standard targets for the unit.

**Content Standard 3**
Students will use form and function to organize and understand the physical world.
**Benchmark A**
Explain function by referring to form and explain form by referring to function.

**Content Standard 10**
Students will know and understand characteristics that are the basis for classifying organisms.
**Benchmark A**
Use information about living things including the roles of structure and function as complementary in the organization of living systems.

One of the most rewarding experiences in Española occurred during an MSA awards night (Fig. 30). Students and parents assembled bringing desserts and applauded the students who were chosen. Teachers picked their own categories such as best attendance, most improved, highest achievement, etc. Parents, teachers,

*Figure 30. Española MSA Awards Night.*

students, and administrators conversed over dessert, and cheered the achievement of the students. Some students shared the poetry they had written in Language Arts, and parents were able to see other poetry that was displayed on the walls (Fig. 31). Again, La Jicarita Enterprises showed their support of the program and helped fund the event by providing part of the refreshments.

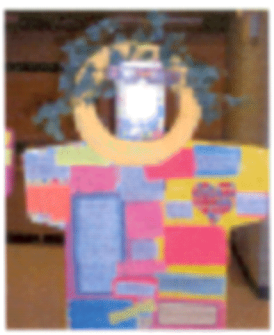


*Figure 31. Poetry on character counts.*

Students in Española participated in an MSA T-shirt design contest. Some of the LANL Foundation grant was used to underwrite the cost of producing the T-shirt. The winning design has a low-rider truck carrying a mountain. The caption under the picture reads, "We Move Mountains." Many students paid a nominal fee to purchase a T-shirt to commemorate their first year in the Math and Science Academy (Fig. 32).


*Figure 32. Student-designed T-shirt.*

Teachers reconvened after the end of school to evaluate their experiences in MSA (Fig. 33). They discussed various aspects of success, difficulties, promising strategies, what to keep, what to change, and what they wanted to include the next year. They also spent time with Ellen Osmundson from CRESST filling out surveys and being interviewed.

*Figure 33. End-of-year evaluation session.*

In July, principals and administrators from the three districts were invited to a leadership institute to find out what the teachers had learned during the year and to participate in some of the same activities (Fig. 34). The conversation about a model that could transfer to the district was initiated so that district people could anticipate the impact on their budgets in subsequent years.

*Figure 34. Administrators' meeting.*

July 23, 2001, was the start of the summer institute for teachers new to the program. There were two teachers replacing two participants from 2000–2001, and ten other teachers were joining the program along with three student teachers. An intensive week was spent trying to give them an experience similar to the 2000 summer institute. The returning teachers joined them for six more days of training. Then all school teams were given four days to work on curriculum design and integration at their school sites. Included in the training was more in-depth work on assessments: rubrics and portfolios, cooperative learning, use of technology in the classroom, and standards-based learning. The whole group worked with Ellen Osmundson on developing an observation instrument. There was also a lot of time spent on team building and community building.

This summer there was a concentrated focus on the use of technology in the classroom. Northern New Mexico Community College opened their doors to MSA and gave teachers access to the outstanding facilities in the Student Success Center. Cathy Berryhill shared her expertise in this area and worked with the teachers to show them how to use the Marco Polo website, as well as the Teacher Tools, Inspiration, Timeliner, and Microsoft Office software programs (Fig. 35). Through the generous contributions of the Regional Educational Technology Assistance (RETA), teachers received free copies of all the software. Teachers this year are required to spend 30 minutes per week, online, responding to posts on the MSA e-group community, checking their e-mails and surfing the Internet for appropriate materials they might use in their lesson planning.

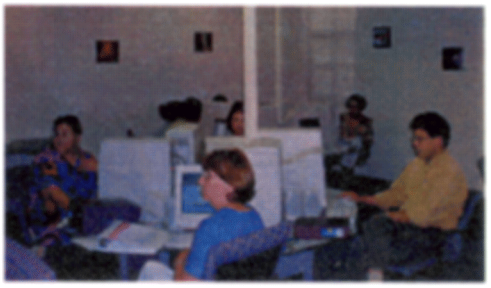


*Figure 35. Teacher technology training.*

All original teachers have computers in their rooms, and work is in progress to provide the same access for all new teachers this year. In addition, there are three laptop computers with external CD burners, zip-drives, and In-Focus projectors, for teachers to check out and use with their classes. The project is anticipating a shift in responsibilities this year from the master teachers to the classroom teachers. MSA teachers are taking on more of the responsibility for

collecting and developing evidence of change in practice. The teachers are asked to present their work to each other, including student products, in preparation for their future work as leaders and mentors in their schools. They will become district mentors helping to lead schools into reform that makes teaching and learning meaningful and efficient for students and teachers. The master teachers' roles are evolving into that of professional developers. In order for systemic reform to take place, everyone, from students, communities, teachers and district administrators, must understand the vision of standards-based education and how to implement it. MSA teachers must mentor other teachers and master teachers/professional developers who will spread the reform throughout the districts.

The following pages are taken from *Cognitive Coaching: a foundation for Renaissance Schools* by Arthur L. Costa and Robert J. Garmston, Christopher-Gordon Publishers, 1994. They illustrate the cognitive coaching protocol that is used with the teachers (Fig. 36).

## Teacher Coaching Sessions, Planning Conference

### Describe

State the purpose of the lesson. What is your lesson going to be about today? What do you want your students to learn? What standard and benchmark are you working towards?

### Translate

Translate the purposes of the lesson into descriptions of desirable and observable student behaviors. As you see the lesson unfolding, what will your students be doing?

### Predict

Envision teaching strategies and behaviors to facilitate students' performance of desired behaviors. As you envision this lesson, what do

**MSA OBSERVATION FORM 2001-2002**

| Date: | Teacher: | Observer: |
|---|---|---|
| Time: | # students: | Demographics: |

| Work setting:<br>Diagram | | | |
|---|---|---|---|
| Student | Teacher | Lesson | Assessment |
| | | | |
| Other observations/comments: | | | |

*Figure 36. MSA observation form layout.*

you see yourself doing to produce those student outcomes?

**Sequence**

Describe the sequence in which the lesson will occur. What will you be doing first? Next? Last? How will you close the lesson?

**Estimate**

Anticipate the duration of activities. As you envision the opening of the lesson, how long do you anticipate that it will take?

**Operationalize criteria**

Formulate procedures for assessing outcomes (envision, operationally define, and set criteria). What will you see/hear students doing that will indicate to you that your lesson is successful?

**Metacogitate**

Monitor your own behavior during the lesson. What will you look for in students' reactions to know if your directions are understood?

**Describe**

Describe the role of the observer. What will you want me to look for and give you feedback on while I am in your classroom?

## Reflecting Conference Math and Science Academy 2001–02

**Teacher-Assess**

Express feelings about the lesson. As you reflect back, how do you feel it went?

**Recall and Relate**

Recall student behaviors observed during the lesson to support those feelings. What did you see students doing (or hear them saying that made you feel that way?

**Recall**

Recall their behavior during the lesson. What do you recall about your behavior?

Compare student behavior performed with student behavior desired. How did what you observe compare with what you planned?

**Compare**

Compare teacher behavior performed with teacher behavior planned. How did what you planned compare with what you did?

**Infer**

Make inferences about the achievement of the purposes of the lesson. As you reflect on the goals for this lesson, what can you say about your students' achievement of them?

**Metacogitate**

Become aware and monitor one's own thinking during the lesson. What were you thinking when you decided to change the design of the lesson? Or what were you aware of that students were doing that signaled you to change the format of the lesson?

**Analyze**

Analyze why the student behaviors were or were not achieved. What hunches do you have to explain why some students performed as you had hoped while others did not?

**Cause and Effect**

Draw causal relationships. What did you do (or not do) to produce the results you wanted?

**Synthesize**

Synthesize meaning from analysis of this lesson. As you reflect on this discussion, what big ideas or insights are you discovering?

**Self-prescription**

Prescribe alternative teaching strategies, behaviors or conditions. As you plan future lessons, what ideas have you developed that might be carried forth to the next lesson or other lessons?

**Evaluate**

Give feedback about the effects of this coaching session and the coach's conferencing skills. As you think back over our conversation, what has this coaching session done for you? What did I do, or not do, for you? What assisted you? What can I do differently in the future?

# The Massachusetts Institute of Technology (MIT) Engineering Internship Program (EIP)

## Program Description

Based on the belief that real-world experience is an important aspect of a sound education, the MIT Engineering Internship Program (EIP) combines the traditional on-campus academics with off-campus work experiences at the Laboratory. By giving students an opportunity to participate in work experiences early in their careers, they can make more informed choices from among the various on-campus educational offerings, as well as obtain a better understanding of career opportunities available after graduation. Emphasis is placed on ensuring that students in the program are placed in rewarding real world work assignments that extend the learning experience into areas that are not available at MIT There is extensive faculty participation and advising in both the on- and off-campus components of the program.

This program provides the opportunity for the participating students (Table 21) to be awarded B.S./M.S. degrees simultaneous upon successful completion of all degree requirements and completion of all three work phases at the Laboratory. Program participants complete a combined B.S./M.S. thesis on a topic related to their work assignment. The thesis topic is normally determined before completion of the second work assignment, and students complete their thesis primarily during the third and final work phase of the program at the Laboratory. All thesis work is completed under the combined supervision of Laboratory staff members and an MIT faculty member.

The Laboratory benefits from the EIP in that it provides a continuum of talented, motivated students, bringing skills and insight to projects of importance to the organization. Many of these students, should they become employees, provide the Laboratory with a competitive advantage as they have already been well-integrated into the objectives, mission and culture of the organization.

**Since the program's inception at the Laboratory in 1983**

- 88 students have participated
- 31 students completed the program

Of the 31 that completed all phases of the program, 11 were formally offered regular UC appointments. Seven accepted the offer of employment and four rejected.

**Table 21. MIT Engineering Internship Demographics**

| Participant Demographics | | | |
|---|---|---|---|
| **Ethnicity** | **Male** | **Female** | **Total** |
| **Anglo** | 4 | | 4 |
| **Asian/Pacific Islander** | 2 | | 2 |
| **Hispanic** | 1 | | 1 |
| **Total** | 7 | | 7 |

Beginning in FY02, the program is being discontinued at MIT. Current participants will have the opportunity to complete the program, but no new students will be recruited into this specific program. Plans are in place to make other opportunities to partner with MIT and their outstanding students available at the Laboratory.

## Highlights of this Year's Accomplishments

In FY 01, there were seven students who participated in the program representing five Laboratory organizations—Design Engineering (ESA-DE) (Figs. 37 and 38), Weapon Engineering (ESA-WE), Engineering Analysis (ESA-EA), Structure/Property Relations (MST-8), and Plasma Physics (P-24).

Of the seven participants, one completed the graduate work phase of the program, and one entered the graduate work phase of the program.

*Figure 37. Dan Moon, ESA-WE Mechanical Engineering.*

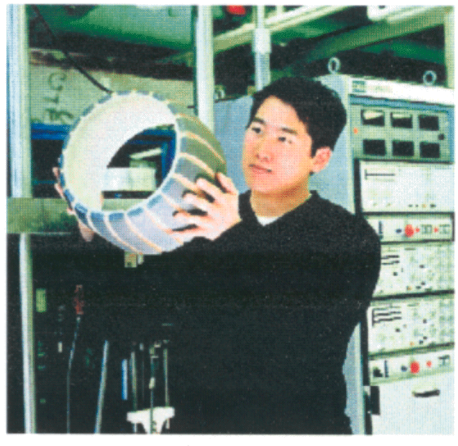


*Figure 38. Warfare aft mount for the Tomahawk cruise missle.*

MOREHOUSE COLLEGE
A proud tradition of producing outstanding leaders

# Morehouse College Program

## Program Description

The Morehouse College Program was established in May 2001 under a memorandum of agreement (MOA) to partner the Laboratory with Morehouse College, Atlanta, Georgia. Under the agreement, students and faculty are invited to engage in science and engineering research at the Laboratory through a summer internship. The agreement established a sustained relationship between Morehouse students and faculty and the Laboratory, thus strengthening the pipeline for future hiring of qualified and capable candidates from one of the nation's premier historically Black colleges.

Ranked number one in the *Black Enterprise* Day Star list as the best college for African-Americans, Morehouse College is the nation's largest liberal arts college for men. Founded in 1867, the college enrolls approximately 3,000 students and confers bachelor's degrees on more black men than any other institution in the nation. Degree granting disciplines include aeronautics/aerospace, astronomy, astrophysics, chemistry, computers/computer science, earth sciences, engineering, life sciences, mathematics, physical sciences, and physics. A five-year dual degree engineering program with the Georgia Institute of Technology (GA Tech) is incorporated into the engineering curriculum through the Dual Degree Engineering Program Office at the Atlanta University Center.

The MOA established that the Science and Technology Base Program Office (STB) at the Laboratory would work with technical divisions at the Laboratory to identify opportunities matching the Morehouse students' research interests with technical staff members who would serve as effective mentors. The students selected to participate in the program become part of the existing Undergraduate Student (UGS) Program, and are compensated according to the policies and procedures for UGS students with similar experience. Students who demonstrate an aptitude for research and who maintain a record of high academic achievement at Morehouse may be invited back to the Laboratory in successive summers. During the academic year, Laboratory mentors maintain ongoing contact with students invited to return.

Morehouse faculty is encouraged to consider both summer research and longer-term sabbatical leaves at the Laboratory during the upcoming year. During a summer research appointment, the faculty members are compensated at a level consistent with the provisions of the Collaborators Special Program (LANL Administrative Manual 1204). Compensation for Morehouse faculty during sabbaticals of periods in excess of six months, but less than one year, is governed by the terms of the Long-Term Visiting Staff Member Special Employment Program (LANL Administrative Manual 1109). STB facilitates identifying appropriate matches between Morehouse faculty and Laboratory technical staff members, and such matches are subject to approval by both Morehouse and the Laboratory. Morehouse faculty is encouraged to submit research proposals to the Laboratory's appropriate technical divisions to foster ongoing research collaborations.

The campus administrator is primarily responsible for the recruitment strategy. Students are targeted within the Packard Scholars Program

located in the Division of Mathematics, Natural and Physical Sciences. However, a visit to the campus to meet with former summer interns and new recruits is recommended to maintain contact and build new faculty, administrative, and student contacts. Morehouse College and the Laboratory agree that a steady state of 15–20 summer undergraduate interns at the Laboratory should be the goal once the partnership matures. To grow the agreement, prior summer research interns are welcomed back in addition to newly recruited students.

## Performance Objective and Milestones

The main performance objective is to establish a sustained faculty collaboration and student internship program between Morehouse College and the Laboratory. The activities to achieve this objective include (1) recruiting the best qualified students and faculty that will benefit most from their research experience at the Laboratory, (2) identifying and securing positive mentor/student relationships, (3) providing a stimulating research environment for each selected participant, and (4) maintaining contact with participants once they return to campus. By meeting this objective and goals, students will be encouraged to continue pursuit of careers in science and engineering. Performance will be measured through follow-up activities with the goal of attracting selected students to the Laboratory as regular members of the technical staff.

Although the agreement did not become official until May 15, 2001, milestones were established and met. These milestones were to:

- Identify participating mentors and line organizations by April 1, 2001.
- Conduct mentor-training by April 15, 2001.
- Review submitted resumes from Morehouse College by April 30, 2001.
- Match students with mentors and positions by May 15, 2001.
- Welcome students to Laboratory and conduct orientation session by June 7, 2001.

## Highlights of this Year's Accomplishments

Ten Morehouse students (Fig. 39) were selected to participate in the program this past year. All were placed in technical areas at the Laboratory.

*Figure 39. LANL Morehouse students.*

**Anecdotal Comments**

According to two of the ten students from the first summer 2001, *"I enjoyed networking with the vast number of other interns. And, I was exposed to new and important information through networking with my mentor, Dr. Charles Milke,"* said Fenyang Stewart, an applied physics major who spent the summer at the National High Magnetic Field Laboratory. Fenyang has been invited back to the Laboratory over the December holiday break and is planning to return next summer.

*"My time here has helped me decide whether or not I should pursue medicine or research in the future,"* noted Kevin Chandler, a chemistry major who spent the summer in the Biosciences Division with mentor, Rashi Iyer. Kevin is planning to continue his research at the Laboratory in summer 2002.

# National Physical Science Consortium (NPSC)

## Program Description

The NPSC is an organization of leading universities, corporations, and national laboratories that provides scholarly and career paths for US citizens, with special emphasis on underrepresented minorities and women in the physical sciences and related engineering fields. The consortium is self-supporting, funded by annual membership fees received from employer members. Current membership includes 111 Ph.D.-granting colleges and universities; 39 sponsoring employers, including Los Alamos National Laboratory; and alliances with the Navajo Nation and the Hispanic Association of Colleges and Universities (HACU). The Laboratory became an employer member in 1989.

The National Physical Science Consortium is a full-time study, Ph.D.-track program. A grade point average of 3.0/4.0 is required for participation in the program. The fellowship requires a student be enrolled in the following fields of study: astronomy, chemistry, computer science, geology, materials science, mathematical sciences, physics, and subdisciplines. Included are specific engineering fields: chemical, computer, electrical, environmental, and mechanical. The fellowship is normally continual as long as the fellow is making satisfactory academic progress and attending full-time, maintains employment eligibility for their sponsoring employer, and maintains satisfactory on-the-job performance at the sponsoring employer's worksite.

The consortium granted its first fellowship awards in 1989 with seven fellows (Table 22). The program is in its 11th year and has had 62 Ph.D. graduates from a total of 258 fellows in the program. The internal breakdown is 51% minority and 49% nonminorities—of which 74% of all fellows are female.

In summary, the National Physical Science Consortium is a unique partnership of industry, national laboratories, and higher education joined together to create a continuous source of US citizen research scientists offering employers and universities the opportunity to add diversity and balance in the workplace. In turn, the program provides opportunities to young, bright future scientists to achieve their academic goals and research aspirations.

## Performance Objective and Milestones

By partnering with the National Physical Science Consortium, the Laboratory plans to increase the existing pool of Ph.D.s in the physical sciences with special emphasis on diversity, while

**Table 22. NPSC Demographics**

| **Participant Demographics** | | | |
|---|---|---|---|
| **Ethnicity** | **Male** | **Female** | **Total** |
| Anglo | 0 | 1 | 1 |
| African American | 0 | 1 | 1 |
| Hispanic | 1 | 1 | 2 |
| **Total** | 1 | 3 | 4 |

supporting the Laboratory's mission. To help achieve this important mission, student research assignments through the National Physical Science Consortium focus on the Laboratory's critical skills areas.

## Highlights of this Year's Accomplishments

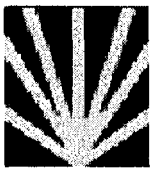
Through leveraging of resources, including cost sharing with sponsoring technical divisions and Lawrence Livermore National Laboratory (one student), the Laboratory was able to support four students through the National Physical Science Consortium during FY01. These students were awarded fellowships in FY99 and met the requirements for continuing in the program during FY01. All four students will continue the program in FY02 if they meet program eligibility requirements.

## Schools Represented

Cornell University
Indiana University
Stanford University
University of Washington

## Participant Profile

One of this year's NPSC fellows, Shannon McDaniel, a Graduate Research Assistant (GRA) at the LANSCE-12 Neutron Scattering Center, received the honor of attending the 51st annual Lindau Meeting held in Germany in June 2001. The meeting brought together 17 Nobel Prize laureates and over 500 graduate students from around the world. This was the second year that United States students were invited to participate. The DOE sponsors American graduate student attendance at the meeting, and each DOE Lab can nominate one graduate representative. Shannon was the Los Alamos National Laboratory GRA nominated to attend this year's meeting. Currently a Ph.D. candidate in geophysics at the University of Washington, Shannon is at LANSCE working full time on the texture analysis of a fossilized sand dollar. Her actual degree work will focus on the rheology or flow patterns of ice under conditions on Earth and on other planets. Her NPSC fellowship is a DOE cosponsored collaboration between Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory. As Shannon explains, "The fellowship supports my tuition and stipend through six years of grad school. It is designed to bring together graduate students and national labs and establish important connections between the laboratories and academia. In return for my cosponsorship through the national labs, I have worked for two summers, one in each lab location. Now, I am here at LANL on a permanent basis to complete my Ph.D."



# Oak Ridge Institute of Science and Education (ORISE)

*Educational and Research Experiences*

## Program Description

The Oak Ridge Institute of Science and Education (ORISE) administers research participation, fellowship, scholarship, and internship programs for the US Department of Energy (DOE) and other federal agencies. In 2000 alone, ORISE placed ~2,300 students and faculty from more than 700 universities at over 100 national laboratories and key research centers nationwide. By identifying future manpower needs in key scientific and technical areas, and connecting talented students with scientific leaders, ORISE is helping to prepare tomorrow's scientific work force.

ORISE is managed by the Oak Ridge Associated Universities (ORAU). ORAU is a consortium of 85 doctoral-granting colleges and universities, including a significant representation of minority-serving institutions. ORAU operates ORISE to provide operational capabilities and conduct research, education, and training for the Department of Energy in the areas of science and technology, national security, environmental safety and health, and environmental management.

ORISE programs target faculty, postgraduates, graduates, and undergraduates involved in a science, mathematics, or engineering discipline. A variety of educational opportunities are available, all of which offer ten- to twelve-week summer practicums at participating US DOE sites. Participants receive guest appointments at the host facility and are not considered to be contractors or employees of the host facility, Oak Ridge Institute of Science and Education, Oak Ridge Associated Universities, or the Department of Energy.

Through its partnership with the Oak Ridge Institute of Science and Education, which began in FY83, the Laboratory strengthens its ties with the academic community while at the same time focusing on developing a highly trained, diverse work force to help meet this country's science and technology needs.

For more information on ORISE, visit http://www.orau.gov/orise/educ.htm.

## Performance Objective and Milestones

Utilizing their state-of-the-art research facilities, the Laboratory, in partnership with the Oak Ridge Institute of Science and Education, recruits and places students and faculty in summer research projects that support the Laboratory's mission and critical skills areas. Research areas focus on theory, modeling, and high-performance computing and nuclear weapons science and technology. Critical Skills Areas #1, Nuclear Design and Evaluation, #2 Physics, #3 High Performance Computing and Simulation.

## Highlights of this Year's Accomplishments

The ORISE programs at the Laboratory had two participants during FY01—one faculty and one graduate research assistant—both of whom were

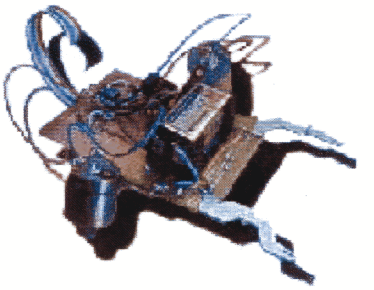
on a three-month appointment. The faculty member was a returning participant from the FY00 program. Both participants planned to continue research collaborations with their Laboratory mentors once they returned to their respective campuses.

- The faculty participant, Dr. Andrew Martinez, is a Professor of Life Sciences, University of Texas-San Antonio. His research at the Laboratory involved carrying out cell biology and molecular biology experiments pertaining to altering cellular gene expression. He performed collaborative research with Drs. Mark MacInnes and Robert Cary of the Biosciences Division. He came to the Laboratory through the ORISE Office of Biological and Environmental Research (OBER) Minority Institutions (MI) Faculty Research Participation Program.

- The graduate student, Benjamin Cipiti, attends the University of Wisconsin-Madison, where he majors in nuclear engineering. His Laboratory mentor was Dr. Richard Nebel, from the Plasma Theory Group of the Theoretical Division. The student's research involved working on the Intense Neutron Source, an inertial electrostatic confinement fusion device. He conducted both experimental and theoretical work. He is a fellow in the ORISE Fusion Energy Sciences Fellowship Program.

# 2001 Robotics Competition

*"The idea of Robotics is to improve robo-genetic stock through stratified competition and have an interesting time in the process."*
– Mark Tilden, Los Alamos National Laboratory



## Program Description

The robotics competition, cosponsored by the Los Alamos National Laboratory and the Santa Fe Art Institute and funded by the US Department of Energy Defense Programs, is aimed at growing and recruiting future Laboratory employees. The primary objective of the competition is to create excitement and interest in science by exposing students to the basics of robotic technology, with the goal of recruiting students into scientific academic pursuits that will lead to future careers at the Laboratory.

The competition is structured as a four-day, graded-level series of workshops and competitions, with the more advanced students (grades 6–12) attending for three days and the beginning students (ages 6–12) attending a basic one-day workshop. While it is called a "competition," the emphasis is on innovation and creativity. The four-day competition culminates each year with local competitions where each student compares his/her work to that of classmates. This friendly competition provides the incentive to create designs that make robots more efficient and capable—a major tenant in the robotic philosophy.

The recruitment strategy for the competition includes site visits and robotic demonstrations at various schools in northern New Mexico; press releases through the Laboratory Public Affairs Office as well as local newspapers like the *La Gente*, Las Vegas, New Mexico; word of mouth; and the robotics website http://set.lanl.gov/programs/robotics/. Students were successfully recruited from Arizona, Colorado, Texas, Kansas, and New Mexico for this year's competition.

## Performance Objectives and Milestones

The Robotics Competition is designed specifically to involve the youth of northern New Mexico and surrounding states in a technology that they can understand and that will excite them—"turn them on" to math and science. It is important to capture the interest of students in science at an early age, and robotics has proven to be a technology that captivates the attention of young minds. By involving youth in such an exciting and touchable technology, we can potentially change their life goals and bring them into the technology base for the Laboratory employment pipeline. This objective is met through

- tracking educational and career aspirations of program participants via a database and ongoing communications;
- inviting Laboratory technical staff members and technicians to attend workshop activities, thus promoting positive relationships and exposing the students and parents to a larger network of scientific knowledge;
- developing a program summer internship component; and
- recruiting the most promising students into the Laboratory pipeline.

## FY01 Milestones

Annual Robotics Competition
May 3–6, 2001
Navajo Nation Workshop
June 15, 2001
UNM-LA Children's College
August 27–September 7, 2001
Floyd, NM, Workshop
November 2001
FY02 Annual Robotics Competition
May 2002

## Highlights of this Year's Accomplishments

The seventh annual Los Alamos Robotics Competition took place in Santa Fe, New Mexico, on May 3–6, 2001. The event had two components: (1) students from grades 6–12 attended the Thursday, Friday, and Saturday advanced workshops, and (2) younger roboticists (ages 6–12) and their parents attended the Sunday afternoon workshop. The competition culminated with informal competitions for both the "solarrollers" and the aesthetic "solarflapper" butterflies on Sunday afternoon.

Seventy-three students from New Mexico and adjoining states attended an advanced three-day workshop. A series of graded-level kits were provided to students as they progressed through the technology, starting with simple solar-engined cars and butterflies and ending with four-motor walkers with heads that detected light sources and guided the walker to follow them. Mentors were available to work with students on demand, providing an intense and satisfying hands-on experience for the participants.

The half-day Sunday workshop had twenty-seven student attendees, each with least one parent or guardian. These participants built the simplest kits—the solar-engined cars and butterflies.

The FY01 competition enjoyed its second year of cosponsorship by the Santa Fe Art Institute (SFAI), who provided space in which to conduct the workshops, dorm space for the workshop mentors, and a lecture hall where students heard nightly talks on robotics and kinetic art. SFAI is an independent, educational, nonprofit organization that annually selects an idea to explore through seminars, residencies, studio/workshops, publications, community lectures, and exhibitions. The competition is fortunate to have the continued in-kind support of SFAI.

## 2001 Robotics Competition Attendance Figures

**Advanced Workshop**
73 student participants, 9 teachers

**Beginners Workshop**
27 student participants

In addition to the annual competition, a robotics workshop was held during the annual University of New Mexico at Los Alamos (UNM-LA) Children's Science Camp, August 27–September 7, 2001. UNM-LA provided robotic kits for more than 400 student participants. Older students who have taken part in past robotic workshops and competitions were used as mentors for the camp, thus allowing the older students to enjoy a mentor experience and play a leadership role. Patricia Chavez of UNM-LA and director of the Children's College said, "the students really enjoyed the hands-on experience of building, testing, and racing the robots. Every year this is one of the most favorite of the classes we offer. Next year we hope to have at least one week of robotics during our Children's College."

Other robotics workshops, sponsored by the Northern New Mexico Systemic Initiative, were held in Shiprock, New Mexico, with over 100 Native American students in attendance. During that same trip 40 high school students from Gallup, New Mexico, were able to interact with scientists from the Los Alamos National Laboratory and students from past robotic events who were serving as mentors. Headlines from the *San*

*Juan Sun* in the Four Corners area stated, "Navajo Nation, Los Alamos scientists work together for youth."

## Comments
## 2001 Robotics Competition

*"I enjoy building robotics and then test them to see if they work"*

*"The competition is always a lot of fun and I like the fact that cheating and making your robot better is encouraged at the competitions."*

*"My teacher uses the activities on the robotic web site. They are fun and we interact with scientists like Mark Tilden from LANL."*

*"I like working with the students who help us build since they are students just like us."*

*"Robotics is fun!"*

*"I never thought my robot would work but after two days it did!!!"*


# South Carolina Universities Research and Education Foundation (SCUREF)

## Program Description

Incorporated in 1998, the South Carolina Universities Research and Education Foundation is a consortium composed of the four major research institutions in South Carolina: Clemson University, the Medical University of South Carolina, South Carolina State University, and the University of South Carolina. The primary goal of the South Carolina Universities Research and Education Foundation is to enhance educational programs and research opportunities of the participating universities through collaboration. The consortium utilizes these universities to manage its research and education programs. One of these programs is the Department of Energy Nuclear Engineering and Health Physics Fellowship/Scholarship (NE/HP) graduate program. The program is managed through the Medical University of South Carolina Office of Special Programs (MUSC/OSP). Los Alamos National Laboratory is one of nine participating centers for the Nuclear Energy and Health Physics program. FY01 was the third year the Laboratory has participated in the program.

For more information on SCUREF, visit http://hubcap.clemson.edu/SCUREF/.

## Performance Objective and Milestones

Through its participation in the Nuclear Energy and Health Physics Fellowship/Scholarship graduate program, the Laboratory supports its mission while focusing on the development of a future work force in Critical Skills Areas #1 Nuclear Design & Evaluation, #2 Physics, and #11 Hazard-Ranked Facility Operations & Security.

## Highlights of this Year's Accomplishments

Two SCUREF fellows were recruited to the Laboratory this year; each served a continuous twelve-week period conducting research.

One Fellow was Brian Miller, Ph.D candidate in nuclear engineering, University of New Mexico, with a 3.9/4.0 GPA. FY01 research was performed in the Computer and Computational Sciences Division under the tutelage of Dr. Raymond Alcouffe, CCS-4 Transport Methods. The research assignment was to develop a first collision source method that included determining the eigenvalue of a fissioning system. The participant, a veteran of the US Navy, served previous internships at Argonne National Laboratory and Brookhaven National Laboratory. This was the participant's second NE/HP summer practicum at Los Alamos.

The other Fellow, Jeffrey King, Ph.D candidate in nuclear engineering, University of New Mexico, had a 4.0/4.0 GPA. FY01 research was performed in the Decision Applications Division under the tutelage of Dr. Laurie Waters, Nuclear Systems Design and Analysis. The research

involved performing physics analysis using the MCNPX code in support of the AAA (Advanced Accelerator Applications) Program. The participant served a previous internship at the Savannah River Operations Office.

# Teacher Opportunities to Promote Science (TOPS)

## Program Description

Teacher Opportunities to Promote Science (TOPS) was a three-year teacher enhancement program conducted by the Education Program Office at Los Alamos National Laboratory for northern New Mexico science, math, and technology teachers and funded by the Department of Energy/Defense Programs. The primary program goal of TOPS was to increase teacher knowledge and skills in the physical sciences, while promoting curriculum alignment and communication through computer networking. Each cohort of TOPS teachers participated in ten meetings and workshops: one two-day orientation at the Laboratory; three two-week summer institutes at the Laboratory; and three two-day regional workshops per academic year (six workshops, in all). Participants received ongoing instruction, tuition assistance, classroom materials and equipment, stipends, and grants, while enjoying interactions with Laboratory education specialists and scientists.

Participants representing all three levels of instruction—elementary (K–5), middle (6–8), and high school (9–12)—formed teams to develop spiral curricula that were inquiry- and constructivist-based and that integrated math, science, and technology. Laboratory scientists and educators acted as mentors on curriculum projects tied directly to ongoing Laboratory areas of scientific research. TOPS teachers learned the skills to develop and post their projects on Websites, thus making the projects available to anyone with Internet access.

As an additional benefit to the participants, the program, in collaboration with the College of Santa Fe-Albuquerque, offered eight 400- and 500- level, three-hour courses in its departments of science and education that could only be taken through participation in TOPS. In March 1999, the New Mexico State Department of Education approved these 24 hours as fulfillment of the requirements to add a science endorsement to secondary New Mexico Teaching Licenses. This option was pursued by 74% of the 1999–2001 TOPS cohort.

## Performance Objective and Milestones

The future of the Laboratory depends in part on how well science is taught in northern New Mexico K–12 classrooms for several reasons. One, the Laboratory employees' children are most likely to attend schools in northern New Mexico. These well-educated parents place a high value on their children's schooling in general, and science education in particular. The Laboratory cannot attract or retain the specialized work force it needs if the schools are not up to the standards that the work force demands. Second, recent reports including the Chiles Commission Report state that the development of scientific, engineering, and technical personnel requires education programs that are targeted toward critical skills and that build upon unique Laboratory resources and capabilities.

TOPS was established at the Laboratory in 1991 with the goal to enhance the overall quality of science, mathematics, and technology education in northern New Mexico's classrooms and school districts. This goal was met by

- Increasing teachers' knowledge of physical science, math, and technology;

- Enhancing teachers' skills in teaching science, math, and technology;
- Providing hands-on activities, materials, and training to take back to the classroom;
- Exposing teachers to the application of science, math, and technology to research at a national laboratory; and
- Developing a Web-based communications network, to provide a strong educational support network among program participants and in their own communities.

Throughout its ten-year history the program directly served almost 300 teachers in over 30 different school districts, benefiting thousands of northern New Mexico school children.

## Highlights of this Year's Accomplishments

October 1, 2000–September 30, 2001 marked the third of three fiscal years of participation for the cohort of TOPS teachers (Table 23) who joined the program in April 1999. Of the 56 participants who originally enrolled in the program in 1999, 37 stayed in the program until its completion in June 2001.

Twenty-six of the 37 teachers opted to register for credit at the College of Santa Fe, thus earning12 additional hours towards the completion of the 24 required to earn a science endorsement through TOPS participation. Participants received daily stipends for attending the workshops and Summer Institute III as well as tuition, where applicable, and hotel costs.

Three regional workshops were held in November, February, and April/May with two three-hour College of Santa Fe education courses being taught at each: EDU596 – Field Experience I and EDU597 – Field Experience II. Normally the TOPS teachers would only take one three-hour course during the school year, but EDU596 was postponed in FY00 due to funding. The course was made up before the end of FY01 in order for the teachers to meet the 24-hour requirement to receive the science endorsement on NM teaching licenses.

### Course Descriptions

EDU596: NM State Department of Education Standards: Theory and Application in the Classroom. This course provided participants in TOPS with the knowledge and tools to develop standards-based units of study based on current curricula.

EDU597: Using WebQuest as a Technology Tool in the Classroom. This course provided participants in TOPS basic instruction and practice in developing standards-based curriculum using the WebQuest strategy. The course focused on integrating the use of computer technology in the science classroom for both research and communication purposes.

The TOPS teachers come from 14 different school districts in 11 different northern New Mexico counties. Over 80% of these teachers are employed in eight school systems where the vast majority (at least 90%) of the student population is Hispanic and/or Native American.

**Table 23. TOPS Workshops 2000–2001**

| Date | Location | Number of Participants |
|---|---|---|
| November 3–4, 2000 | Four Corners | 18 |
| November 17–18, 2000 | Los Alamos | 26 |
| February 9–10, 2001 | Four Corners | 12 |
| February 23–24, 2001 | Los Alamos | 25 |
| April 27–28, 2001 | Four Corners | 12 |
| May 4–5, 2001 | Los Alamos | 25 |

Table 24 is a summary of the demographics of the TOPS teachers themselves:

Summer Institute III. The third and final two-week summer institute was held at the Laboratory on June 11–22, 2001. The curriculum had two main components:

- PHY 402: Applied Modern Physics and Material Science - covered the three nuclear processes (radioactivity, fission, and fusion). Topics of radioactivity covered included kinetics of decay; particles emitted; detection of particles; ability to block particles; and dangers, uses, and sources of radiation. Lab work in radioactivity was conducted. Concepts in fission and fusion included writing equations to represent processes, energy and use in generation of electricity; natural and synthetic production of elements; and historical development of understanding the three processes. This course built upon the material covered in Applied Modern Physics 401 (TOPS 1999, Summer Institute I).

- EDU 595: Curriculum for the Web provided participants with instruction and practice in how to create and edit Web pages, and how to manipulate graphics, sound, and text to deliver content-specific science curriculum on the World Wide Web. Participants also learned methods of navigating the Web in search of science content resources and technology tutorials. Several software titles supporting the course goals were introduced and explored.

In addition to PHY 404 and EDU 595, the teachers attending the summer institute enjoyed a TI-83+ calculator workshop, a robotics workshop and a material science workshop, plus two tours of highly specialized Laboratory facilities—the Trident Laser Facility, and the National High Magnetic Field Laboratory.

Summer Institute III ended with a celebration luncheon and graduation ceremony on June 22 that was well attended by family members of the teachers, representatives from the College of Santa Fe, and Laboratory staff members.

Numerous formative and summative evaluations of workshops and seminars were conducted throughout the course of the TOPS program. At completion of the program, participants were asked to evaluate their overall three-year TOPS experience and reflect on the impact it had on their professional and personal development.

**What were your biggest gains from being in TOPS?**

- A better understanding of LANL's mission and purpose.
- Technology; knowledge of radioactivity and atomic theory; information to share with students regarding the role of LANL.
- Working on lessons that can be used in the classroom. Acquiring the use of technology and adapting it for use with students.
- The confidence level boost in using computers as a source of information and even as a teaching tool. I know a lot more science than

**Table 24. 2000–2001 TOPS Cohort**

| Ethnicity | Number |
|---|---|
| African American | 1 |
| Caucasian | 18 |
| Hispanic | 12 |
| Native American | 6 |
| Gender | |
| Female | 6 |
| Male | 31 |

I did before I started. Eye opener was dispelling misconceptions students may have.
- Learning about subatomic particles and getting to know the teachers of northern NM.

**What were your biggest disappointments about TOPS?**

- Didn't last long enough!
- I think there were no disappointments about TOPS. I really enjoyed all of it.
- That it will not continue – I wish more elementary teachers could learn what I have. Thanks for everything!

**If TOPS or some version of it were to be funded in the future, what changes would you suggest? What would you hope remains the same?**

- The technology component definitely needs to stay. Maybe add more mathematics. The study time this year was great. The availability of the computer classroom after hours was very helpful to completing our projects.
- More AIMS-type activities – that's all I would change – it was really worthwhile!
- Lock in credits at beginning of program.
- I think TOPS was OK in every way. I was hoping it would continue so my son could attend.
- In the future, I hope/suggest that a program such as TOPS continues to fund teachers to purchase computer programs and other teaching materials for their classrooms.

All the teachers expressed a sincere "thank you" to the Department of Energy/Office of Defense Programs for supporting the TOPS program the past ten years and to the Laboratory for its commitment and dedication to make the program the success that it was.

# Section 4

# Participant Data

## Supported by the Department of Energy Office of Defense Programs

# Critical Skills Development and Science Education Programs

# FY2001 Participant Data–Critical Skills Development and ScienceEducation Programs

## Table 25. Precollege Student Participants

| Program Title | Black Male | Black Female | White Male | White Female | Hispanic Male | Hispanic Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adventures in Supercomputing | 2 | 1 | 75 | 23 | 39 | 16 | 18 | 27 | 6 | 0 | 34 | 12 | 253 |
| Dev Info Sys Careers | 0 | 1 | 0 | 0 | 1 | | | | 0 | 0 | 0 | 0 | 2 |
| Go Figure | 0 | 0 | 15 | 15 | 30 | 16 | 16 | 14 | 0 | 0 | 0 | 0 | 106 |
| Math and Science Academy | 3 | 2 | 29 | 34 | 331 | 324 | 17 | 19 | 0 | 0 | 0 | 0 | 759 |
| Robotics | 1 | 0 | 25 | 18 | 32 | 12 | 5 | 1 | 3 | 2 | 1 | | 100 |
| Total | 6 | 4 | 144 | 90 | 433 | 368 | 56 | 61 | 9 | 2 | 35 | 12 | 1220 |

# FY2001 Participant Data–Critical Skills Development and ScienceEducation Programs

## Table 26. Undergraduate Student Participants

| Program Title | Black Male | Black Female | White Male | White Female | Hispanic Male | Hispanic Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| College Co-op | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Dev Info Sys Careers | 0 | 0 | 9 | 1 | 11 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 28 |
| Drexel | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Education Intern Program UC-LANL | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| High Explosives Eng Training Program | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Los Alamos Physical Summer School | 1 | 0 | 13 | 4 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 20 |
| Los Alamos Dynamics Summer School | 0 | 0 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| Mat Sci Tech | 0 | 0 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Math and Science Academy | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Massachusetts Inst of Tech Eng Intern Program | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Modern -*f* Element Chemistry | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| Morehouse College | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| Nuclear- and Radiochemistry | 0 | 0 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 9 |
| Total | 10 | 0 | 59 | 11 | 16 | 9 | 1 | 0 | 1 | 2 | 0 | 1 | 110 |

# FY2001 Participant Data–Critical Skills Development and ScienceEducation Programs

## Table 27. Graduate Student Participants

| Program Title | Black Male | Black Female | White Male | White Female | Hispanic Male | Hispanic Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dev Info Sys Careers | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| GEM | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Hertz | 0 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 12 |
| High Explosives Eng Training Program | 0 | 0 | 15 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 21 |
| Los Alamos Dynamics Summer School | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Massachusetts Inst of Tech Eng Intern Program | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 |
| Modern -*f* Element Chemistry | 0 | 0 | 8 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 13 |
| National Physical Science Consortium | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Nuclear- and Radiochemistry | 0 | 0 | 7 | 5 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| Oak Ridge Inst of Science and Education | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| SC Univ Research and Education Foundation | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Total | 0 | 3 | 37 | 12 | 7 | 5 | 0 | 0 | 3 | 0 | 1 | 0 | 68 |

# FY2001 Participant Data–Critical Skills Development and ScienceEducation Programs

## Table 28. Faculty

| Program Title | Black Male | Black Female | White Male | White Female | Hispanic Male | Hispanic Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| College Co-op | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Expanding Your Horizons | 0 | 1 | 0 | 5 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| GEM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Go Figure | 0 | 0 | 1 | 5 | 9 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| High Explosives Eng Training Program | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| LASSO | 0 | 0 | 4 | 8 | 1 | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 20 |
| Mat Sci Tech | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Math & Science Academy | 0 | 0 | 2 | 4 | 11 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 27 |
| Modern *-f* Element Chemistry | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Nuclear- and Radiochemistry | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Oak Ridge Inst of Science and Education | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| Robotics | 0 | 0 | 4 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| Teacher Opportunities to Promote Science | 0 | 1 | 5 | 13 | 0 | 12 | 2 | 4 | 0 | 0 | 0 | 0 | 37 |
| Total | 0 | 2 | 28 | 39 | 22 | 47 | 2 | 4 | 0 | 0 | 1 | 0 | 146 |

# Critical Skills Development and Science Education Programs

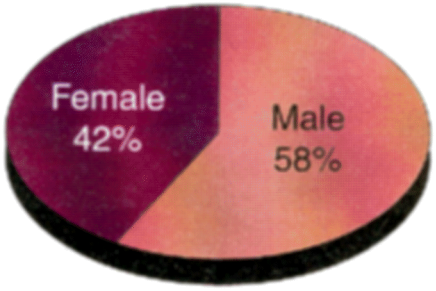



*Chart 10. Gender.*

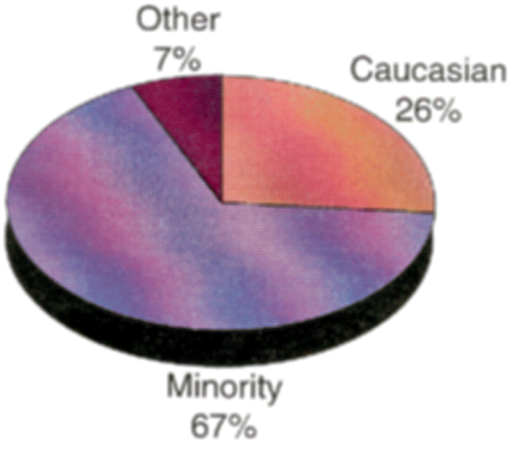



*Chart 11. Ethnicity.*

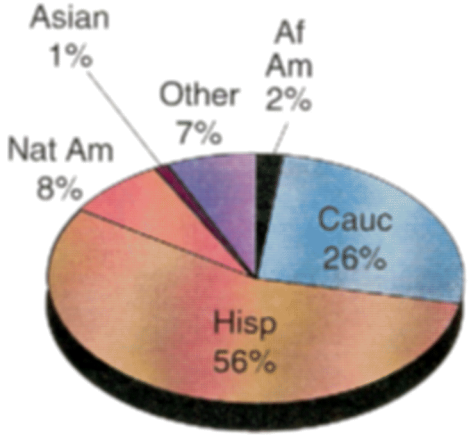



*Chart 12. Diversity breakdown.*

# High School Co-op, Undergraduate and Graduate Programs

## Table 29. FY01 Participant Data—High School Co-op

| Precollege Student Participants | AM IND/AL NAT | | | ASIAN/PAC ISLAND | | | BLACK | | | HISPANIC | | | WHITE | | | OTHER | | | Total All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | |
| HS Co-op | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 4 | 26 | 3 | 2 | 5 | 2 | 0 | 2 | 35 |
| HS Co-op new hires | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 1 | 31 | 3 | 3 | 6 | 0 | 0 | 0 | 38 |
| HS Co-op TEC | 0 | 1 | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 4 | 5 | 9 | 5 | 8 | 13 | 0 | 5 | 5 | 30 |
| HS Co-op TEC new hires | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 3 | 13 | 7 | 12 | 19 | 0 | 1 | 2 | 36 |
| Post HS Admin new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Post HS Tec new hires | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Post HS Tec new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Total Precollege** | 3 | 5 | 8 | 0 | 2 | 2 | 0 | 0 | 0 | 67 | 14 | 81 | 18 | 25 | 43 | 2 | 6 | 9 | 142 |

## Table 30. FY01 Participant Data—Undergraduate

| Undergraduate Student Participants | AM IND/AL NAT | | | ASIAN/PAC ISLAND | | | BLACK | | | HISPANIC | | | WHITE | | | OTHER | | | Total All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | |
| Developing Info Systems Careers | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 11 | 18 | 1 | 9 | 10 | 0 | 0 | 0 | 28 |
| Elec-Mech Tec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 0 | 4 | 4 | 0 | 0 | 0 | 12 |
| Elec-Mech Tec new hires | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 0 | 0 | 0 | 0 | 1 | 1 | 10 |
| Intern Tec | 0 | 0 | 0 | 1 | 2 | 3 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 7 |
| Intern Tec new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 3 | 0 | 0 | 0 | 4 |
| Mach/Fab Tec | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 11 | 0 | 2 | 2 | 0 | 1 | 1 | 15 |
| Mach/Fab Tec new hires | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 7 |
| Post BS Admin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | 2 | 0 | 2 | 0 | 0 | 0 | 6 |
| Post BS Admin new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 4 | 2 | 6 | 0 | 1 | 1 | 10 |
| Post BS Tec | 1 | 1 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 6 | 8 | 13 | 17 | 30 | 0 | 4 | 4 | 46 |
| Post BS Tec new hires | 0 | 1 | 1 | 1 | 2 | 3 | 1 | 0 | 1 | 1 | 2 | 3 | 22 | 17 | 39 | 1 | 1 | 2 | 49 |
| Undergrad Admin Aide | 3 | 0 | 3 | 2 | 0 | 2 | 1 | 1 | 2 | 123 | 20 | 143 | 41 | 6 | 47 | 2 | 3 | 6 | 202 |
| Undergrad Admin Aide new hires | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 31 | 9 | 40 | 15 | 5 | 20 | 2 | 2 | 4 | 65 |
| Undergrad Co-op Intern Program | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 6 | 0 | 0 | 0 | 6 |
| UCIP-Tec new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| Undergrad Tec | 9 | 8 | 17 | 10 | 12 | 22 | [redacted] | 1 | 2 | 3 | 62 | 111 | 173 | 105 | 172 | 277 | 8 | 18 | 27 | 518 |
| Undergrad Tec new hires | 2 | 5 | 7 | 1 | 2 | 3 | 0 | 10 | 10 | 26 | 32 | 58 | 45 | 87 | 132 | 7 | 8 | 17 | 225 |
| **Total Undergraduate** | 16 | 18 | 34 | 17 | 18 | 35 | 4 | 14 | 18 | 259 | 221 | 480 | 251 | 333 | 584 | 20 | 40 | 64 | 1,211 |

# Table 31. FY01 Participant Data—Graduate

| Graduate Student Participants | AM IND/AL NAT | | | ASIAN/PAC ISLAND | | | BLACK | | | HISPANIC | | | WHITE | | | OTHER | | | Total All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | Female | Male | Total | |
| Admin Resrch Asst | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | 0 | 3 | 3 | 0 | 0 | 0 | 7 |
| Admin Resrch Asst new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 5 |
| Developing Info Systems Careers | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 4 |
| GEM Rsrch Asst | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| GEM Rsrch Asst new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| HBCU Rsrch Asst | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| HERTZ Rsrch Asst new hires | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 11 | 0 | 0 | 0 | 12 |
| Natl Physical Science Consortium | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 3 | 1 | 0 | 1 | 0 | 0 | 0 | 5 |
| Post MS Admin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Post MS Admin new hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| PostMS Staff Rsrch Asst | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 11 | 14 | 25 | 1 | 2 | 4 | 32 |
| Post MS Staff Rsrch new hires | 0 | 0 | 0 | 1 | 3 | 4 | 0 | 1 | 1 | 0 | 2 | 2 | 5 | 9 | 14 | 0 | 1 | 3 | 24 |
| Staff Intern | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 2 | 3 |
| Staff Member | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| Staff Rsrch Asst | 3 | 2 | 5 | 10 | 19 | 29 | 3 | 3 | 6 | 8 | 14 | 22 | 58 | 132 | 190 | 8 | 25 | 34 | 286 |
| Staff Rsrch Asst new hires | 2 | 0 | 2 | 7 | 14 | 21 | 2 | 3 | 5 | 5 | 6 | 11 | 18 | 55 | 73 | 2 | 6 | 8 | 120 |
| **Total Graduate** | 5 | 2 | 7 | 19 | 37 | 56 | 7 | 8 | 15 | 25 | 26 | 51 | 97 | 227 | 324 | 12 | 37 | 53 | **506** |
| **Total All Students** | 24 | 25 | 49 | 36 | 57 | 93 | 11 | 22 | 33 | 351 | 261 | 612 | 366 | 585 | 951 | 34 | 83 | 126 | **1,859** |

## High School Co-op, Undergraduate, and Graduate Programs

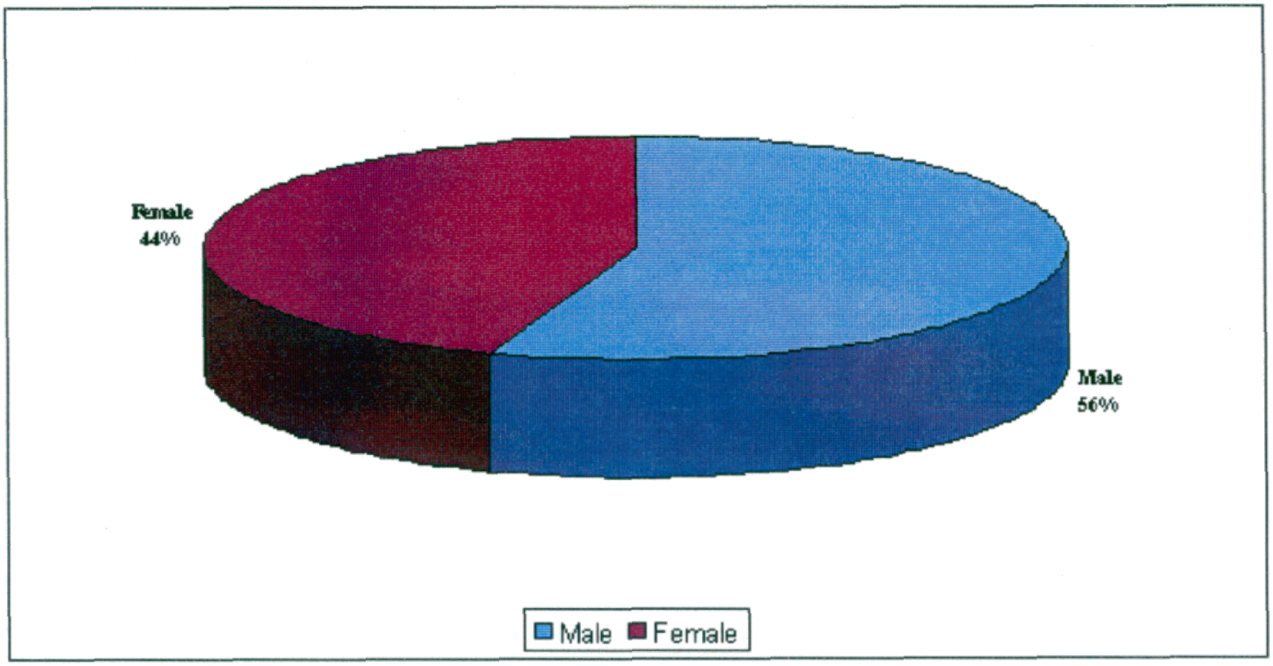



*Chart 13. Gender.*

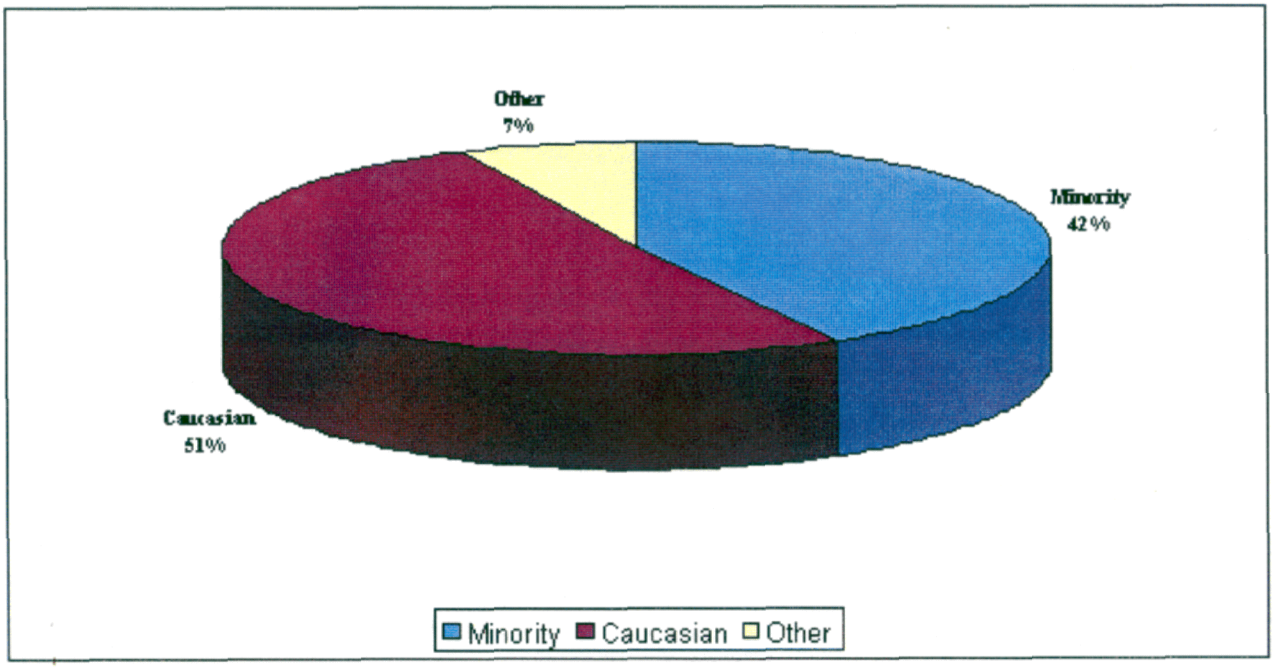



*Chart 14. Ethnicity.*

## High School Co-op, Undergraduate, and Graduate Programs

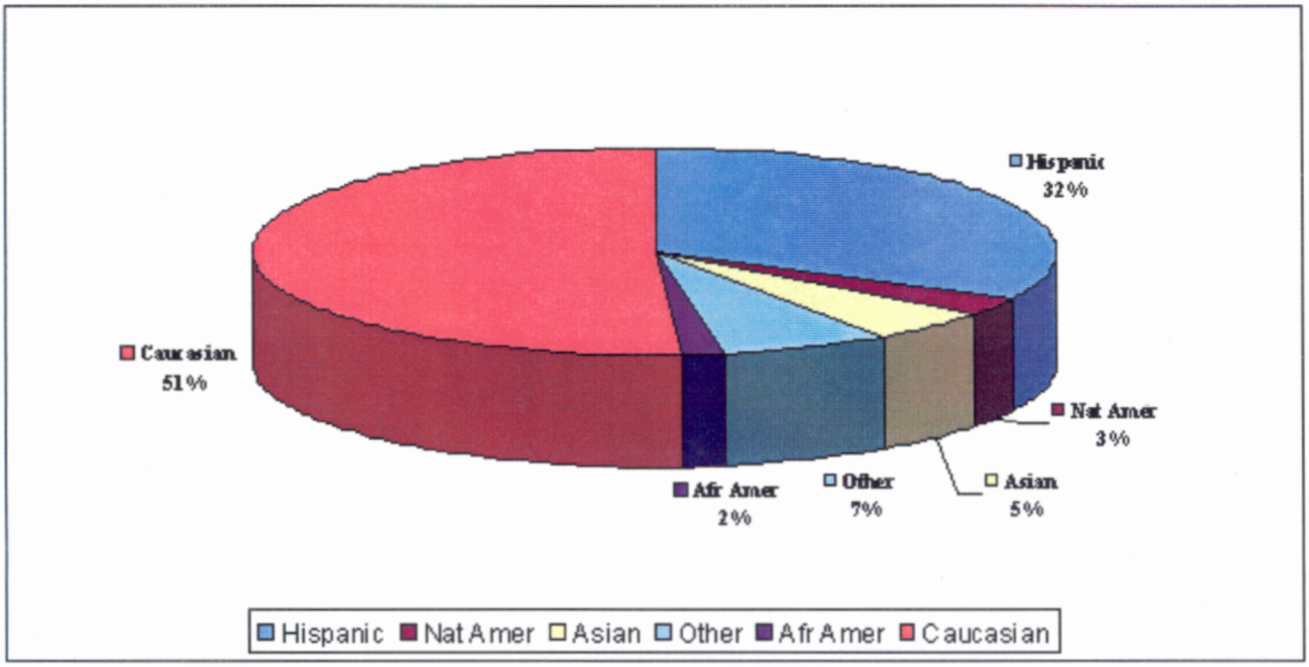



*Chart 15. Diversity breakdown.*

# List of Acronyms

AAA: Advanced Accelerator Applications program at the Laboratory
AMO: atomic, molecular, and optical
ASCI: Advanced Strategic Computing Initiative
ATA: Associates of Technical Arts CCN-12
CCN: Computer, Communications, and Networking Division of the Laboratory
CCN-2: Desktop Group
CCP: College Co-op Program
CCS Computer and Computational Sciences Division of the Laboratory
CCS-4: Transport Methods Group
C: Chemistry Division of the Laboratory
CDF: Cambridge Documentary Films
CDF: colliding beam experiment at Fermilab
CINT: Center for Integrated Nanotechnologies
C-INC: Isotope and Nuclear Chemistry Group, Chemistry Division of the Laboratory
CQI: continuous quality improvement
CRESST Center for Research on Evaluation, Standards, and Student Testing
C-SIC: Structural Inorganic Chemistry Group, Chemistry Division of the Laboratory
CST: Chemical Science and Technology Division
CTBS: Comprehensive Test of Basic Skills
CTCM: Critical Thinking Curriculum Model
D: Decision Applications Division of the Laboratory
D-4: Energy and Environmental Analysis Group
DOE: Department of Energy
DMFC: direct methanol fuel cells
DP: Defense Programs (Office of the Department of Energy)
DX: Dynamic Experimentation Division of the Laboratory
DX-2: High Explosives Science and Technology Group
EdCC: Edmonds Community College
EMRTC: Energetic Materials Research and Testing Center (at New Mexico Tech)
EIP: Engineering Internship Program
EPO: Education Program Office
ESA: Engineering Science Applications Division of the Laboratory
ESA-EA: Engineering Analysis Group
ESA-AET: Applied Engineering Technologies Group
ESA-DE: Design Engineering Group
ESA-WMM: Weapons Materials and Manufacturing Group
ESA-WE: Weapons Engineering Group
GATE: Graduate Automotive Technology Education Program
GA Tech: Georgia Institute of Technology
GED: general equivalency diploma
GEM: National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc.
GPA: grade point average
GRA: graduate research assistant
HACU: Hispanic Association of Colleges and Universities

HE: high explosive(s)
ICPEAC: International Conference on Photonic, Electronic, and Atomic Collisions
IM: Information Management Division of the Laboratory
IM-2: Customer Service Group
IM-4: Imaging Services Group
IMAC: International Modal Analysis Conference
IT: information technology
ITS: Institute for Transactinium Science
LANL: Los Alamos National Laboratory
LANSCE: Los Alamos Neutron Science Center
LASS: Los Alamos Summer School
LASSO: Los Alamos Space Science Outreach Program
LEEG: Laboratory Educational Equipment Gift
LLNL: Lawrence Livermore National Laboratory
MAES: Society of Mexican American Engineers & Scientists
MESA: Math, Engineering,& Science Achievement
MI: Minority Institutions
MOA: memorandum of agreement
MPTC: Multi-Platform Trusted Copy (software)
MSA: Math and Science Academy
MST: materials science and technology (also the Materials Science and Technology Division of the Laboratory)
MST-8: Structure/Property Relations Group
MUSC/OSP: Medical University of South Carolina Office of Special Programs
NASA: National Aeronautics and Space Administration
NE/HP: Nuclear Engineering and Health Physics, SCUFEF (see below)
NESS: Nuclear Explosives Safety Study
NIS: Nonproliferation and International Security Division of the Laboratory
NIS-1: Space and Atmospheric Sciences Group
NIS-9: Weapon Design Technologies Group
NMT: New Mexico Tech
NMT: Nuclear Materials Technology Division of the Laboratory
NNMCEE: Northern New Mexico Council for Excellence in Education
NPSC: National Physical Science Consortium
NRCs: Nanoscale Science Research Centers
NSF: National Science Foundation
OAAT: Office of Advanced Automotive Technologies
OBER: Office of Biological and Environmental Research, Oak Ridge Institute of Science and Education
OBES: Office of Basic Energy Sciences (DOE)
ORAU: Oak Ridge Associated Universities
ORISE: Oak Ridge Institute of Science and Education
P: Physics Division of the Laboratory
P-24: Plasma Physics Group
PEM: polyelectrolyte membrane
RETA Regional Educational Technology Assistance
REU: Research Experience for Undergraduates

SFAI: Santa Fe Art Institute
SCC: Strategic Computing Complex (at the Laboratory)
SCUREF: South Carolina Universities Research & Education Foundation
SLEPs: Stockpile Lifetime Extension Program
SPRT: sequential probability ratio test
STB-EPO: Science and Technology Base Programs–Education Programs Office
TOPS: Teacher Opportunities to Promote Science
TSM: Technical Staff Member (at the Laboratory)
UGS: Undergraduate Student Program
UNM-LA: University of New Mexico, Los Alamos Branch
WERC: Waste-Management Education and Research Consortium